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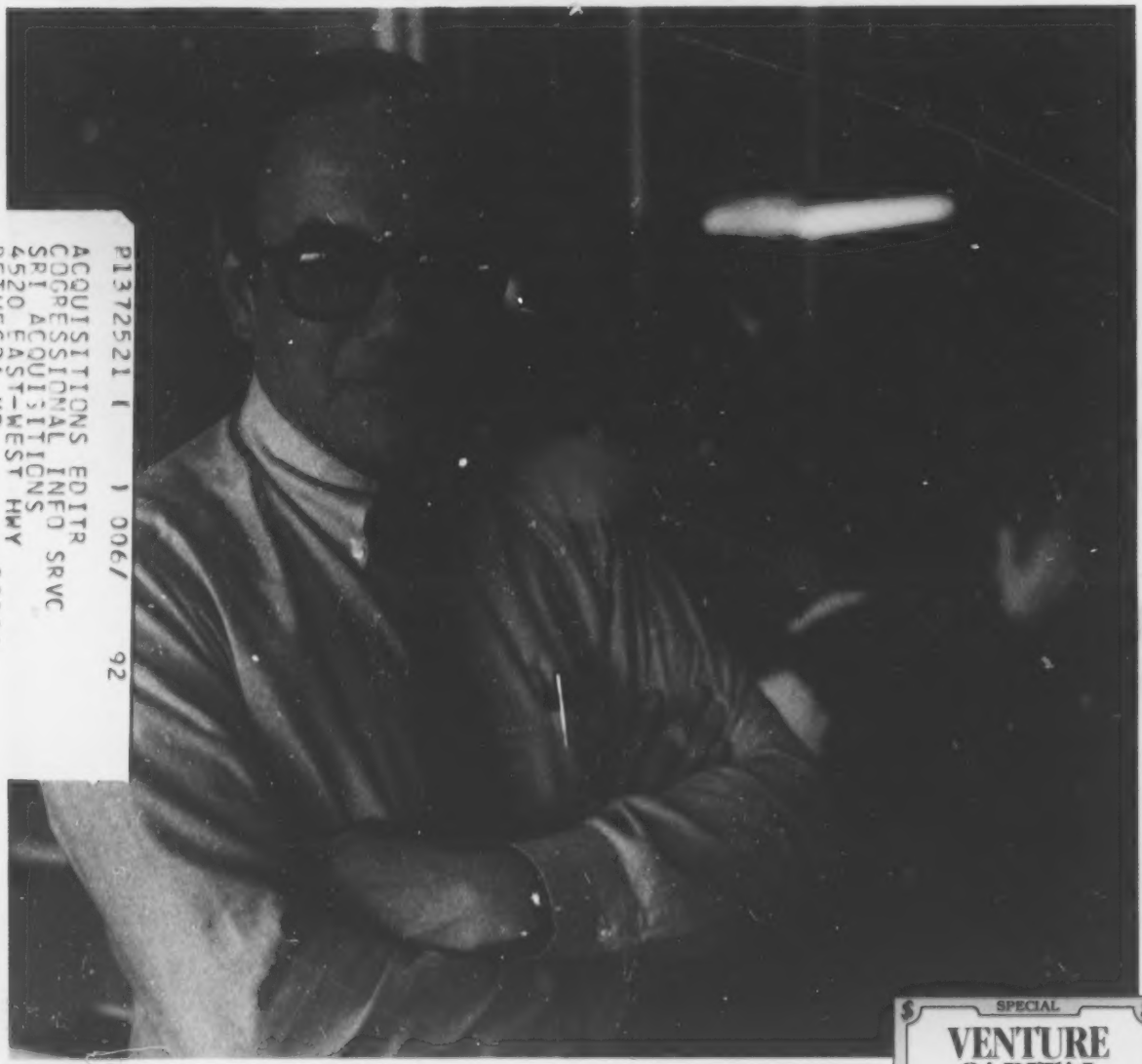
Electronic Business

Disk drives: Satisfying a high-performance marketplace

CMOS: A $5.5 billion business for complementary chips



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Lew Platt: Fine-tuning HP's manufacturing strategy

SPECIAL
VENTURE CAPITAL
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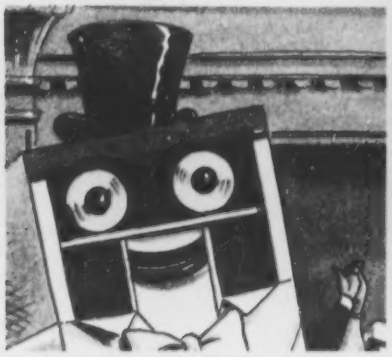
Electronic Business

VOL. 13, NO. 10 — MAY 15, 1987

THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY



PAGE 30

PAGE 60

PAGE 90

BUSINESS TRENDS

30 Package selling reshapes computer maker marketing
Computer makers turn away from the hard-sell hardware pitch to the softer solution sell.

44 The 5.25-inch format for high-end disk drives
The workstation market continues to thrive, and with it, the market for high-capacity 5.25-inch disk drives

50 The laser photoplot (for PCBs) thickens
Laser plotters are starting to make inroads into vector plotter territory because of their fast turnaround.

54 Score a point for Yankee ingenuity
Guess who manufactures some of the chips used in many Japanese cameras? Try Honeywell's Colorado fab facility.

AN EDITORIAL INDEX OF ALL COMPANIES DISCUSSED IN THIS ISSUE CAN BE FOUND ON PAGE 130

MANAGEMENT

60 At Hewlett-Packard, the word is CIM
Under Lew Platt, HP is developing a piecemeal strategy for the computer-integrated manufacturing market.

75 Beckman Industrial shows some marketing muscle
If you've got it, flaunt it. That's how Beckman plans to gain share in the resistant resistor market.

80 How CFOs view the Tax Reform Act of 1986
The electronics industry may profit from reform, but the economy will suffer, some CFOs claim in a poll.

VENTURE CAPITAL

107 Venture capital: Knowing when the price is right
Venture capitalists say there's still money available for start-up electronics firms in uncrowded niches.

112 ELECTRONIC BUSINESS' listing of venture capitalists

MARKETS

90 CMOS acceptance spawns complementary markets
As the technology has moved into more and more segments, CMOS chips have become a $5.5 billion business.

98 Pushing the boundaries of CMOS technology
Physical limitations and fabrication problems are key issues to watch as CMOS ICs approach new geometries.

DEPARTMENTS

4 Inside Business

9 Update

17 Business Barometer: The outlook for U.S. computer production brightens.

24 Letters

126 Emerging Companies: Analog Design Tools for analog engineers.

127 Japan Report: Corporate AI R&D accelerates in Japan.

128 Calendar

130 Editorial Index

132 Viewpoint: Replicating Silicon Valley outside of the U.S.

Cover photo/Reg Francklyn

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The outlook for U.S. computer production brightens

The trade deficit in computers and office equipment widened last year, but Cahners projects growth

If the squeaky wheel gets the grease, then the U.S. computer and office equipment industry should learn to squeak louder. While much attention has recently focused on the U.S. semiconductor industry's screams for help, the U.S. computer and office equipment industry has long been suffering in silence.

Last year the U.S. trade deficit in computers and office equipment totaled a whopping $4.6 billion, sharply up from $1.1 billion the year before, according to Analytics, a market research firm located in Palo Alto, Calif. For the first half of this year, Analytics is predicting a $2.3 billion deficit.

Nevertheless, Cahners Economics — our in-house forecasting unit — remains optimistic about 1987, predicting a 6.4% rise in the U.S. production of computers and office equipment (SIC 357). Regarding quarterly growth, Cahners says U.S. production will grow by about 2.5% this quarter, 3.5% during the next quarter and 4.5% during the fourth quarter of this year. By the end of this quarter, in fact, Cahners estimates that the industry be well on its way to surpassing the previous peak in SIC 357 production from two years ago. For 1988, Cahners says U.S. production will increase by 13%.

"Computer manufacturers received an estimated $1.87 billion in new orders in January," Cahners reports. That was down sharply compared with December when a year-end flurry of buying activity, due in part to the new tax law, pushed orders to $5.78 billion. Shipments also got off to a slow start this year, in line with the normal seasonal pattern, our economists also note. January's total was $2.55 billion, down from $6.28 billion in the prior month. "New product cycles," our forecasters add, "continued improvement in exports, and a pickup in U.S. business investment is still expected to carry the market upward in 1987."

Nevertheless, the trade deficit still worries Analytics. The deficit in the industry is most acute with data-processing equipment where the deficit was $3.3 billion last year. In addition, the United States also imported last year more than $1 billion worth of photocopiers than it exported. All told, imports currently account for around 13% of the U.S. market for computers and office equipment, estimates Analytics.

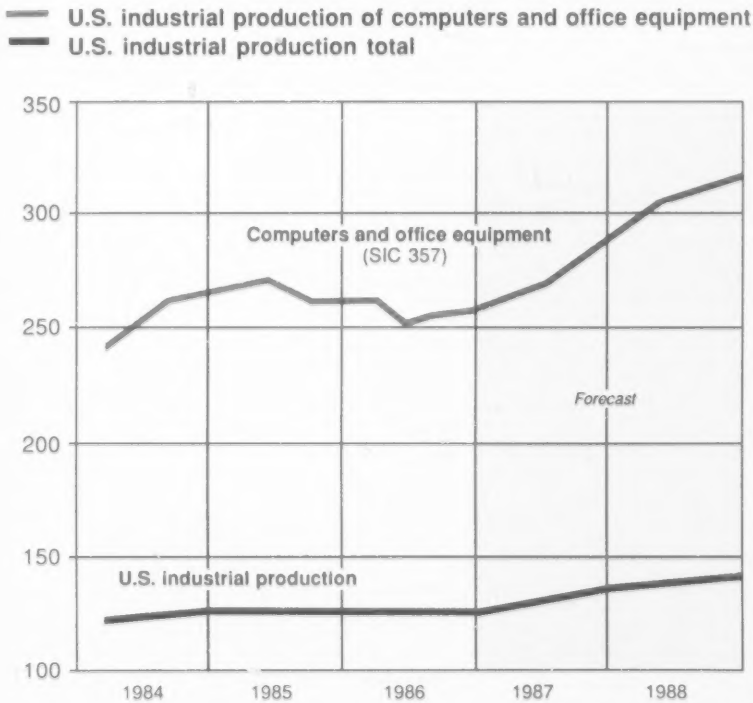
Many market analysts foresee a further widening of the trade gap, due in part to an increase in offshore manufacturing which has been recently fueled by the U.S.-Japan semiconductor trade agreement. One result of the agreement has been higher chip prices in the United States which provide yet another reason for U.S. systems manufacturers to relocate manufacturing operations offshore.

Looking further ahead, Analytics is predicting that the U.S. production of computers and office equipment will increase by only 1.9% this year, a substantial change from last year when production fell by nearly 15%. It agrees with Cahners, however, for 1988, predicting a 13% increase over this year.

ALDEN M. HAYASHI

Computers and office equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical machinery (including electronic components and communication equipment) operated at 71.7% of capacity during the fourth quarter of 1986, up slightly from the third quarter's 71.4% rate. This increase corroborates other evidence that the industry has begun to emerge from the slump which began in mid-1984. Orders for most nondefense electronic products have accelerated in recent months, so plant operating rates are expected to show further near-term increases. Manufacturers should be operating at approximately 75% of capacity by the end of 1987 and at least 80% by late 1988.

Instruments

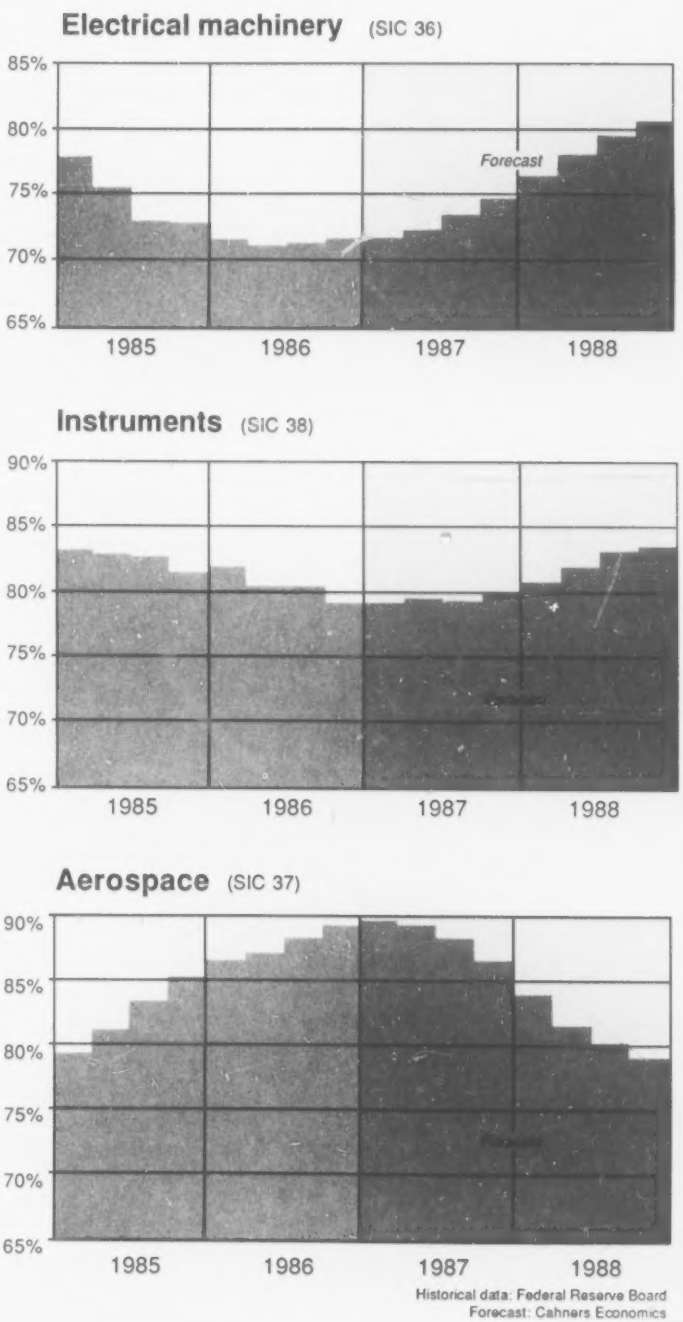
The rate of plant utilization in the instrument industry fell to 79.2% in the fourth quarter from an average of 80.3% in the previous three months. This was the ninth consecutive quarterly decrease and was a sign that production volumes continued to be restrained by weakness in U.S. capital spending. Although order rates are expected to start off slow in 1987, we expect capital investment levels to pick up somewhat after mid-1987, spurring increased production activity for instruments. The industry's operating rate will fluctuate near present levels through the summer but are expected to begin a sustained rise toward the end of the year, finishing 1987 at about an 80% rate. A further increase of three or four percentage points is expected to follow next year.

Aerospace

In the fourth quarter of 1986, the aerospace equipment industries utilized 89.2% of plant capacity. This was an extremely high rate by historical standards and represented an increase of nearly a full percentage point over the prior quarter. Recent reports suggest that utilization rates will remain in an 89% to 90% range in early 1987, but the recent squeeze in defense procurement authority should cause production activity to level off later in the year. These developments will pull the operating rate down slightly, to a fourth quarter average of approximately 86% to 87%. Look for more rapid declines in 1988, with the rate waning to nearly 80% by year-end.

Plant utilization

Average percentage of capacity utilized per quarter



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components and accessories

Many categories of electronic components, including capacitors, connectors and some types of semiconductors, experienced mild upward price pressures in late 1986. This pushed industry-wide prices up 0.3% in the fourth quarter, to a level which was more than 2.7% above the year-earlier period. This compared with an increase of just 1% for the entire first half of the year. Prices should continue to push upward over the course of 1987 as the unfolding business recovery gains momentum. Following a modest overall increase of 1.8% in 1986, prices are expected to climb approximately 3.2% this year and 4.4% next year.

Linear ICs

Fourth-quarter producer prices of linear ICs fell 3.5%, their sharpest downward move in nearly two years. On an annual basis, prices fell 5.1% compared to 1985. The declines came despite a fairly healthy improvement in the domestic market during 1986. According to the Semiconductor Industry Association, U.S. bookings for linear ICs increased 36% last year, and shipments achieved an 18% growth rate. As the market continues to pick up in 1987, supply conditions should begin to tighten and prices should start to climb. By year-end, prices are expected to be up nearly 10% from a year earlier and that steady climb will lead to an overall annual rise of 1.3%. An increase of 2.7% is expected in 1988.

Digital bipolar ICs

Producer prices for digital bipolar ICs, which had dipped slightly last summer, turned up again in the year's fourth quarter as demand from computer manufacturers and most other major end-user markets resumed an upward trend. Prices rose 1% in the final quarter and registered an overall increase of 4.1% for 1986 as a whole. Most industry analysts expect this market segment to show a moderate but sustained rise in 1987, and such an improvement in business conditions would be likely to trigger further increases in prices. They are currently expected to rise 9.6% in 1987 and about 8% next year.

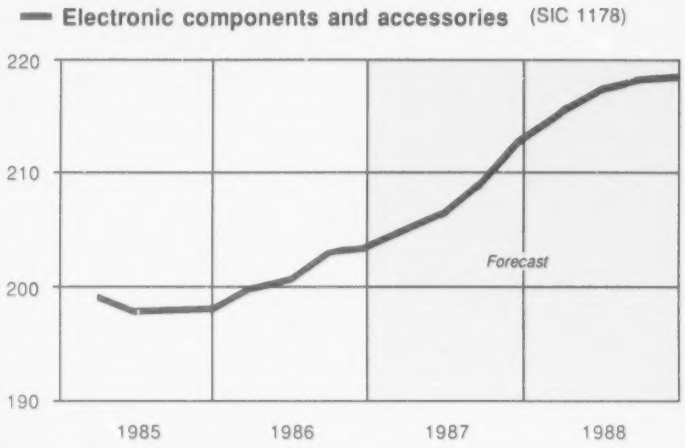
Digital MOS ICs

Prices of digital MOS ICs rose 3.1% in the fourth quarter of 1986, reversing the prior quarter's decline. Despite this uptick, prices were down sharply for the year, averaging 10.1% below the level in 1985. Reports for early 1987 suggest that prices continue to push upward, and we expect rising demand to help sustain this pattern well into the second half of the year. Annually, prices are forecast to increase 7.6%, their first rise since 1984 when the last business expansion was at its peak. Pricing will be more stable in 1988, showing an average decline of about 2.5%.

Producer price indexes

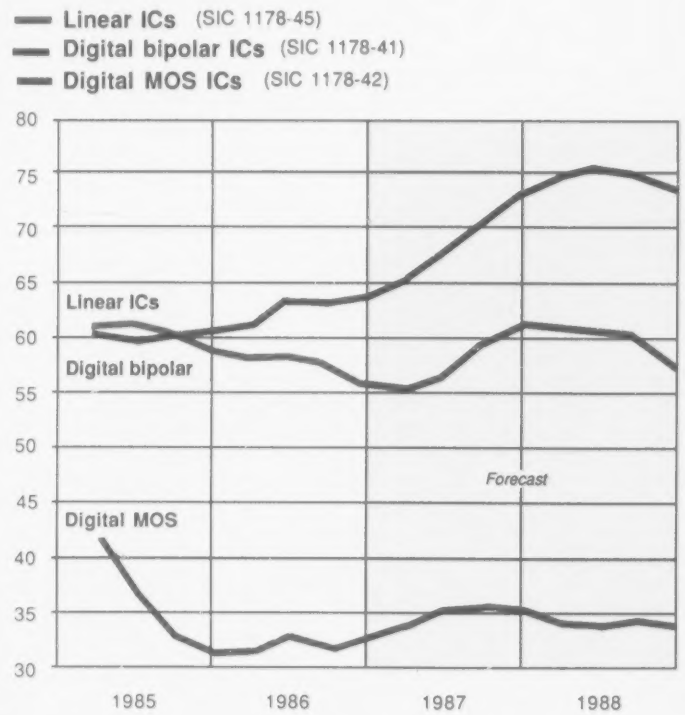
Electronic components

December 1967 = 100, quarterly averages



Integrated circuits

December 1974 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

Package selling reshapes computer maker marketing

Computer makers turn away from the hard sell hardware pitch to the softer solution sell

"In the late '70s, early '80s, deregulation hit and Hogan was in the right place at the right time," says Richard Aldridge, executive vice president for field operations at Hogan Systems. Deregulation, in this case, was in the banking industry and Hogan, a developer of financial software for IBM mainframes, was sitting pretty. Sales at the Dallas-based software house zoomed, doubling three years in a row.

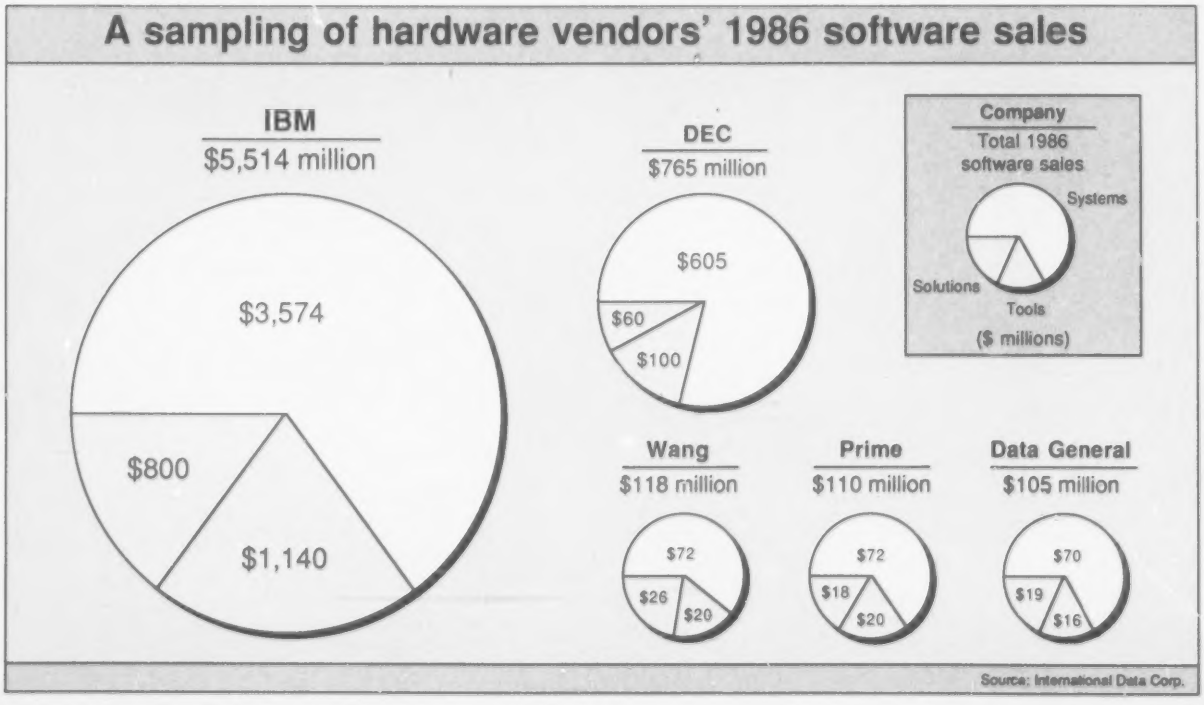
Then things started to slip. Hogan had a tough time keeping pace with its own growth. The company's service and support, says Aldridge, became the worse for wear. Then Hogan made the mistake of shipping product before it was ready. In March 1984, the company released a new integrated loan package and mailed it off to 54 customers before testing the software. The results, says Hogan's vice president, were disastrous. "The package had gaping holes in it," explains Aldridge. "Our references fell apart, the competition had a field day and our sales dried up."

Then the company found itself in the right place again. IBM, aware of Hogan's presence in the financial world, approached the software company about a joint marketing deal. In May 1986, after 12 weeks of negotiations, IBM and Hogan signed five separate contracts that in sum gave the computer manufacturer exclusive rights to market Hogan software in the United States, Canada and Puerto Rico.

"I have read [in the press] that it was a one-way deal," says Aldridge. Many industry analysts portray it that way. The Hogan-IBM agreement, says Ted Jastremski, an analyst with Framingham, Mass., market research firm International Data Corp., "walks and talks like an acquisition." Says Mark Pines, also with IDC, "The Hogan deal amounts to IBM buying its way into a market."

Hogan, though, is certainly benefiting from the agreement, too. The software company has virtually eliminated its sales and marketing costs in North America. Its customers, says Aldridge, are pleased that their software investment is now secured by IBM backing despite the fact that IBM has raised the price of the software approximately 20%. And Hogan is raking in between $800,000 and $1 million a month due to Big Blue's influence. Anyway, says Aldridge, "it was inevitable that Hogan would have to team up with someone."

Teaming up seems to be the catch phrase in the computer industry today. Another buzzword is "solutions." Almost every computer manu-



facturer is turning away from the hard sell hardware pitch of yesterday to the softer solution sell, which, as a complete package approach, includes both hardware and software. IBM and Unisys Corp., among other hardware makers, both have recently reorganized their sales organizations according to market, rather than geographic, boundaries. Salespeople at the computer makers now target specific vertical markets and talk complete solutions — such as an IBM 3090 mainframe running Hogan's Integrated Banking Applications — to the end user.

The evolution of IBM

"IBM wants to evolve into a full-service supplier," says Robert F. Borland, group director for strategy requirements and quality assurance for IBM's Information Services. But IBM, and the same can be said of any other computer manufacturer, cannot be all things to all people — at least not by itself. Realizing that, Digital Equipment Corp., Hewlett-Packard Co., IBM and many others are forging more partnerships with software companies.

Some match-ups involve exclusive contracts like the IBM-Hogan agreement. Other computer makers have made equity investments in, or made acquisitions of, software houses that target interesting markets. Wang Laboratories Inc., for example, has an equity stake in Custom Software Services, which writes software used in law, and acquired Walsh, Greenwood Information Services Inc., a financial package writer.

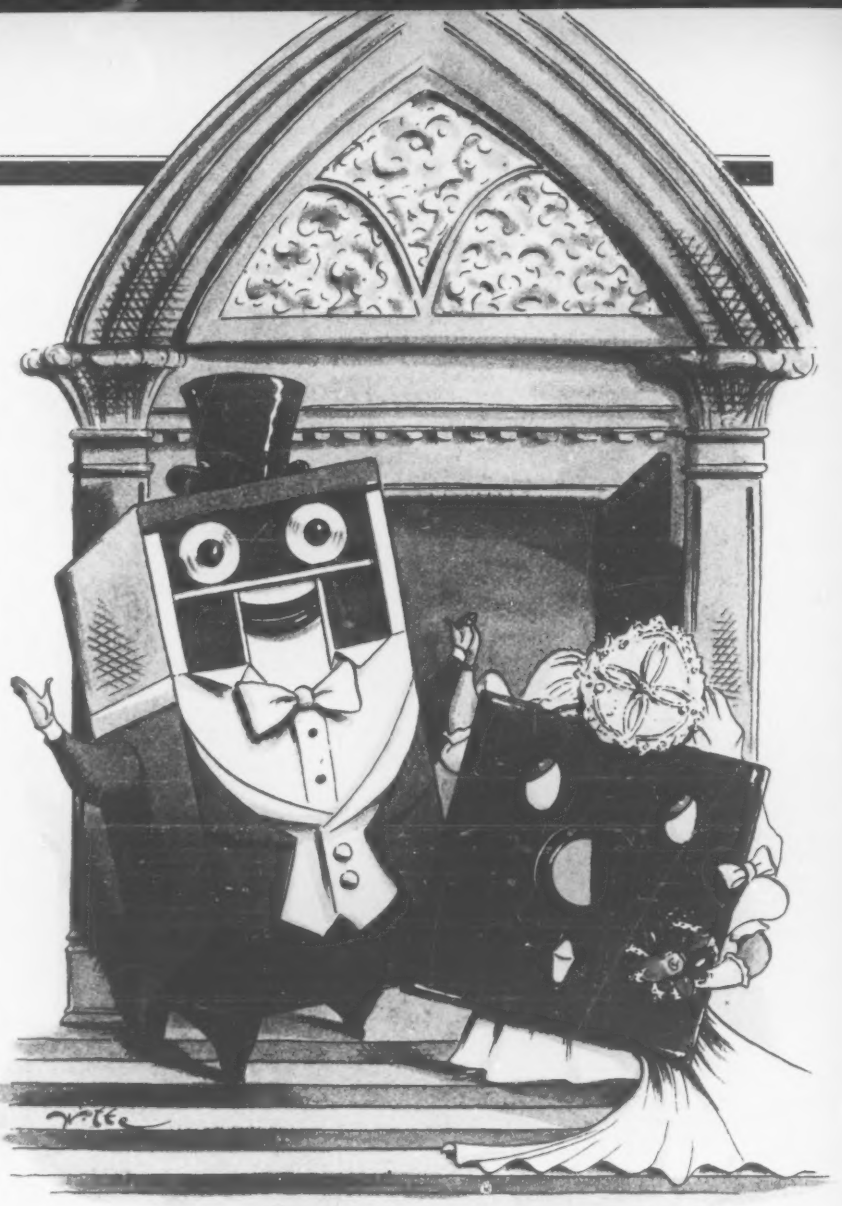
Probably the most prevalent type of arrangements are joint marketing agreements. Some involve sales calls made jointly by both hardware and software salespeople. Others require that the computer vendor supply the software company with sales leads. And many are informal referral arrangements; a hardware salesperson supplies a list of software packages written by third parties to prospective customers.

For most computer manufacturers, establishing partnerships with software companies has required some rethinking of corporate policy. "It is a major strategic shift for a hardware supplier that has grown up in the culture of doing everything itself," says James Turner, director of Unisys' worldwide cross-industry program. "You have to eliminate the NIH factor — 'not invented here.'" And it may require a change in focus. "A few years ago the emphasis [at IBM] was on hardware and systems software," says Borland. Today, he says, the emphasis is on application software and service.

But today, in-house development at most computer companies is still concentrated in systems software. According to Peter Burris, a software analyst with IDC, the software business is divided into three tiers. On the bottom of the pyramid is systems software, primarily the operating system. Next are utilities and tools such as language compilers and programming tools. These two blocks of the pyramid have naturally gone to hardware makers, especially those with proprietary operating systems, such as DEC's VMS and IBM's MVS.

Computer makers have been happy with the systems and tools business. Combined, the two are a $11.65 billion business. Both types of software have higher margins than hardware; IDC's Jastremski says that IBM, for example, reportedly makes 50% margins on its software. Systems and tools are generic software that can be sold to every customer regardless of application; and they represent guaranteed, recurring revenue because end users, for the most part, are locked into buying, servicing and updating them.

Application packages, on the other hand, are prone to competition, says Harvey Poppel, partner at New Jer-



Michael Witte

Teaming up seems to be the catch phrase in the computer industry today

sey-based acquisition and merger specialist Broadview Associates. In addition, manufacturers have limited software resources and systems and tools have to be considered first. "It depends upon the market opportunity," says Michael Galane, R&D lab manager of Hewlett-Packard's Manufacturing Productivity division. "But there is always a higher priority on systems software."

Customers are also looking for more application packages, or complete solutions today, says John Doherty, manager of DEC's earth resources Cooperative Marketing Program (CMP). Even large oil companies, which have been writing their own software for years, want hardware vendors to provide turnkey systems.

Last, but not least, writing application software for any market demands expertise in that particular industry. But computer manufacturers have expertise in a relatively small portion of the overall market for computer systems.

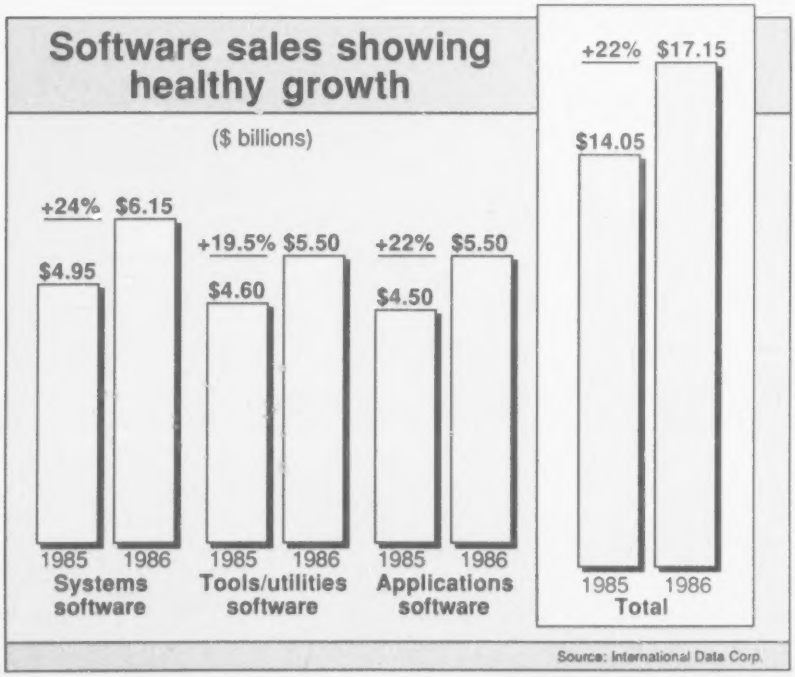
"To develop software for a particular market," says HP's Galane, "requires a lot of knowledge about the market and the user." If a hardware company wants to sell software developed in house for an application that it has little first-hand experience in, says Galane, one of three things has to occur. The company has to either "port the expertise" by contracting it out to consultants; "hire the expertise" by recruiting employees experienced in the application's industry; or "do a poor job."

DEC's EARL COOK, manager of electrical CAE/CAD marketing, says engineering-oriented applications "are our family jewels"

The supposed change in emphasis on application packages brings independent software vendors (ISVs) into the picture out of necessity. IBM's philosophy, says Borland, is "to develop only that which we have expertise in." IBM sells some application software written in house. For example, the company offers MAPIX, its own general ledger and accounts receivable package for manufacturing. HP markets its own Manufacturing Resource Planning (MRP) software written in house — particularly for high-end systems and sophisticated users — and also sells manufacturing software developed by third parties. In the manufacturing market, HP also has a few original equipment manufacturer (OEM) deals, including one with ASK Computer Systems Inc., and joint marketing deals like the one with Computer Solutions Inc., a writer of MRP software for first-time users.

DEC, on the other hand, uses and sells MRP software from NCA Corp., exclusively marketing NCA's MAXIM MRPII software in the Far East. (DEC sells MRP packages developed by a number of ISVs The company's manufacturing planning and control systems group offers about 300 application packages, all of which have been written by third parties.) DEC markets few in-house developed application packages, but it does sell some proprietary computer-aided software engineering (CASE) packages. DEC would rather keep most packages to itself, especially engineering-oriented applications. "Those," says Earl Cook, DEC's manager of electrical CAE/CAD (computer-aided engineering and design) marketing, "are our family jewels."

Distinct third-party programs, however, designed to handle relationship with ISVs and value-added resellers (VARs), are relatively new departments at most major computer makers. "Until very recently, hardware



Henry Hilland/Picture Group

companies regarded software as a necessary evil," says Broadview's Poppel. "It is only in the last two or three years that support programs [at hardware companies] have become extensive."

But today almost every major computer maker has formal third-party programs. DEC implemented its Systems Cooperative Marketing Program (SCMP) — for software companies that resell DEC hardware themselves — and its CMP — for companies that sell their software in conjunction with DEC hardware — about two years ago. The programs originated in DEC's mechanical division, says George Novoson, manager of mechanical applications at the minicomputer maker. The programs expanded, says Novoson, into all divisions at DEC and resulted in corporate-wide policies and guidelines for third-party relationships. The restructuring, says Novoson, "was a major change for the company."

Today, DEC's electrical CAE/CAD division has about 15 ISVs and "many more OEMs," according to Cook. Its mechanical CAD department has "close to 30 software partners and six resellers," says Novoson. And its earth resources division, says DEC's Doherty, is working with about nine ISVs.

Tandem Computers Inc. has grown its list of affiliated third-party software houses from 35 in 1983 to 250 through its Alliance program, started in late 1985. Wang Laboratories' Marketing Assistance Agreement program gives third-party software houses 4% to 12% of the net sale of Wang hardware if their package is sold with it. IBM's Vendor Logo Program, geared toward software for its Personal Computer, allows IBM to act as a distributor for a number of third-party application packages, says Borland.

The list goes on. Software makers, too, are establishing divisions for third-party agreements with hardware makers. They are equally eager to establish mutually rewarding agreements with hardware suppliers.

Cullinet Software Inc., for example, recently set up an original equipment manufacturer sales division, headed by James G. Blake, vice president of the company's distribution channels division. Within a month the division had signed deals with two OEMs — Cognos and Measurex. Says Blake: "Why should they [hardware companies] reinvent the wheel? With the market being the way it is, it's always best to stick to your own knitting."

Cullinet has also made its own software acquisitions. Last year the company bought Computer Strategies Inc., a writer of repetitive manufacturing software. In January, Cullinet purchased Planning Control International Inc., a government-reporting, project-management and financial-tracking software developer, for $4.3 million. And analysts are waiting to see how well Cullinet will fare against the IBM-Hogan duo when the company brings out new financial packages later this year developed by Bob White Systems Inc., another Cullinet acquisition.

> Distinct third-party programs are relatively new departments at most computer makers

Cullinet is not the only software company getting in on the act. Management Science America Inc., for instance, bought Arista and Comserve, two MRP software companies. In addition, MSA bought Information Associates Inc., and RTS Ltd., an Irish writer of real-time software. MSA, which is known for its financial mainframe software, wants to expand its markets, in part because of the threat presented by the IBM-Hogan deal and also due to the opportunity presented by DEC's growing presence in manufacturing.

"We're beginning to move our focus into the minicomputer environment," says Keith Cooley, executive vice president at MSA. "We're not migrating mainframe packages down to minis. There is a need for distinct packages, especially in manufacturing." Adds Cooley: "The DEC area is obviously one we need to address."

Maintaining these partnerships — both formal and informal — is a balancing act for both hardware vendors and software suppliers. Ideally, computer makers would like as many applications running on their machines as possible. To accomplish that, hardware companies have to encourage many software developers to write

Fortune's pet tiger

For some computer makers, software represents more than an add-on to its hardware sales; it may be salvation.

Fortune Systems Corp., for example, decided to spin off its software division into a wholly owned subsidiary when the popularity of its word-processing package was growing faster than its hardware sales. That way, says Susan Espy, vice president and general manager of Tigera Corp., the newly formed software subsidiary, Fortune could capitalize on its software strengths by selling in high volume to some of Fortune's direct competitors.

Tigera, established in June 1986, now sells Word Era, its newly named word-processing package, through original equipment manufacturing agreements with Convergent Technologies, Plexus and Pyramid Technology Corp. This year alone, Tigera plans to spend 60% of its operating budget on the development of new software products.

Convergent, faced with the withdrawal of AT&T's and Burroughs' OEM business, says Harvey Poppel, partner at New Jersey-based Broadview Associates, has had to completely restructure its business. In the process, Convergent has made a number of software acquisitions including the purchase of Display Data Corp., a writer of software for the distribution and wholesale industry. "It is a whole repositioning of the company," says Poppel.

Other acquisitions that have occurred recently in the software industry, according to W.T. Grimm & Co., a merger and acquisitions firm in Chicago, are: Ashton Tate bought Decision Resources Inc., a maker of business graphics software, for $13 million; Harris Corp. purchased Scientific Calculations, a developer of computer-aided design software, for $30 million; Intergraph Corp. bought CNR Research Company Inc., a CAD software writer, for an undisclosed amount; Lotus Development Corp. acquired both Graphic Communications Inc. and Infocenter Software; Microsoft Corp. bought Dynamical Systems Research Inc. for an undisclosed amount; Silvar Lisco purchased NCA Corp. for $5 million; and Ungermann Bass Inc. acquired Linkware Corp., a writer of market information exchange software. □

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JULY IN

Electronic Business

July 1

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software for their systems. At the same time, computer makers do not want to alienate any potential allies.

The Hogan-IBM deal is a case in point. Many analysts conclude that IBM did not buy Hogan because of antitrust concerns. IBM's Borland says legal complications had nothing to do with it. Broadview's Poppel agrees. He says that despite the fact that the deal is a "de facto acquisition," IBM did not buy Hogan because it did not want to risk offending other financial software companies.

For IBM, that may be beside the point. Companies that write software for mainframes have to write for IBM machines; IBM owns about 75% of the mainframe market, and at least another 3% to 5% goes to plug-compatible makers. DEC also has such a presence in certain markets that few software companies cannot compete in those markets unless they write applications for VMS. In fact, says IDC's Jastremski, many software companies are jumping on the DEC bandwagon because they are afraid IBM is going to shut them out. "Software vendors are looking at the DEC platform as a haven," he says.

Hardware competition

Meanwhile, many hardware companies want to sell some of their own applications, too. "We make it clear to third parties that we have proprietary software that competes with them," says HP's Galane. "Our obligation is to tell them where we are positioning our product." Says Galane: "The challenge is to position all those products so customers don't get confused and third parties don't get in our way."

Some analysts think that if anyone gets in anyone's way it will be hardware companies knocking down software companies. "Hardware vendors are definitely going to make their presence known," in the applications market, says IDC's Jastremski. Considering that applications software is a $4.5 billion business, growing 22% annually, computer makers may not be able to refuse the business.

"As software becomes more of a margin business, hardware companies are looking to make more money off it," says MSA's Cooley. "There is certainly a possibility that hardware companies will bring software development in house more and more." But Cooley is not too worried. "I don't think any of them, including IBM, think they can write all the applications."

ANNE KNOWLES

The 5.25-inch format for high-end disk drives

The workstation market continues to thrive, and with it the market for high-capacity 5.25-inch disk drives

Like consumers everywhere, computer users are constantly demanding more for less, particularly in the area of storage. The 5.25-inch disk drive, the latest and smallest in a long line of high-capacity disk drive products, is the current target for much of this demand. Meanwhile, once standard 8-inch drives are slowly being edged out in favor of smaller form factors.

According to John Hime, Sun Microsystems Inc.'s director of product marketing, "we could sell our customers a gigabyte of memory today if it was available in a 5.25-inch format. Our customers can use all the disk space we are giving them and then ask for more."

Responding to this need are a bevy of vendors introducing high-capacity products in a 5.25-inch form factor in sizes ranging from 190MB to 760MB. Although few doubt this is the ultimate direction the market is taking, this move by vendors to ramp up to very high capacity may be premature at best. Some analysts, in fact, wonder if disk drive technology is once again outpacing demand.

"We are not near the end of the road for medium capacity products," asserts San Jose, California-based Quantum Corp.'s marketing director Rolf Brauchler. By medium capacity, most analysts mean products in the 100MB to 300MB range.

Despite announced or shipped product from a number of companies — including Control Data Corp., Fujitsu Ltd., Maxtor Corp., Micropolis Corp., NEC Corp., Priam Corp. and Toshiba, the existing market for true high-capacity drives is still relatively small.

According to market research firm Disk/Trend Inc. of Mountain View, Calif., the market for 300MB to 500MB 5.25-inch disk drives reached $75 million in 1986 and could reach $460 million by 1989, compared with the market for medium capacity drives — those between 100MB and 300MB — which was $276 million in 1986, and could be worth more than $1.3 billion in 1989. The market for drives with more than 500MB of capacity is negligible, Disk/Trend adds, with that market accounting for less than $21 million in revenue by 1989.

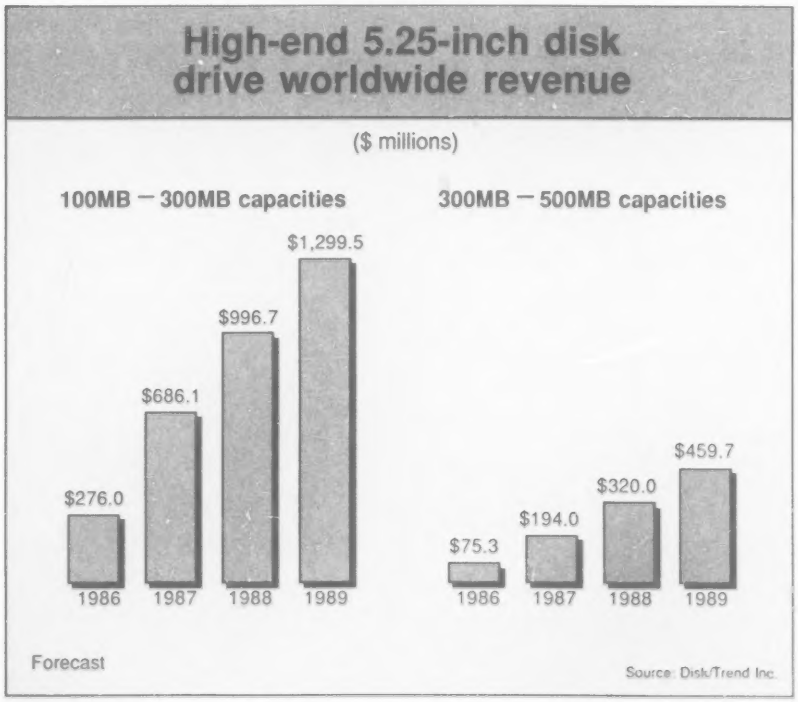
San Jose-based Maxtor already has taken an early lead in the high capacity 5.25-inch disk drive market. To date, the firm has shipped 10,000 units of its 380MB drive, and it claims it was the first to announce a 760MB drive, which will be available at the end of the year.

Competitors, however, are quick to point out that the battle is not yet over. Priam's director of product marketing John Hagerman, for example, says that key potential customers are only "just evaluating the products, and have not selected vendors at the over-300MB level. The votes are not in," he says.

International Data Corp.'s senior industry analyst David Vellante explains why. "Maxtor has to continue to outpace the rest of the industry," Vellante says. About "80% of Maxtor's business is in the under-200MB range, but 90% of Maxtor's talk is about the over-200MB range." This is premature, Vellante believes, because the only thing that a disk drive vendor must do to stay in the race is announce a 380MB product this year, even if it ships it next year. The biggest chunk of the market over the next 12 months to 18 months will be in the midcapacity 190MB range, he says, so companies like Priam, Micropolis and Quantum are far from out of the running. In fact, Micropolis in particular, which has a strong position in the popular 190MB product range should have a strong sales year in 1987, Vellante says.

Other forces are at work as well. Although it would be easy to overlook the presence of 8-inch drives in the market today, most workstation vendors are continuing to use 8-inch and even larger products to fulfill users' memory needs. The reasons are fairly simple. David James, Hewlett-Packard Co.'s product manager for high-end disk drive products in Boise, Idaho, says that his company has to consider both cost and environment when installing a system.

In the past, the very high-capacity 5.25-inch drives that have been available have not matched the performance of the larger drives, James says. In that context, although size is important in the workstation market,



performance is more important, and HP has yet to integrate any very high capacity drives in the 5.25-inch form factor. "The new drives from Micropolis and Maxtor are just coming out, and it does take HP a long time to integrate a drive in a system."

The nature of Sun Microsystems' business often makes the choice of an 8-inch drive possible, product marketing director Hime adds. "Workstations are pretty big anyway. These systems have big 19-inch monitors and take up a lot of desk space. I'm not sure we would trade capacity for a smaller form factor." That is one reason why Sun, a leading U.S. workstation vendor, has yet to introduce a 5.25-inch disk drive of more than 190MB. The company, Hime says, must take time to ensure reliability. "We are willing to trade off 10% to 20% in performance in order to get 10% to 20% better quality and reliability," Hime says.

On the other hand, the trend toward higher and higher capacity is inevitable. According to Disk/Trend's vice president Robert Katzize, "the general trend in the market is up," he says. "Partly that is because software is bigger and more people are using machines at once, and partly because the machines are used for more and more applications. All of this puts pressure on the drive."

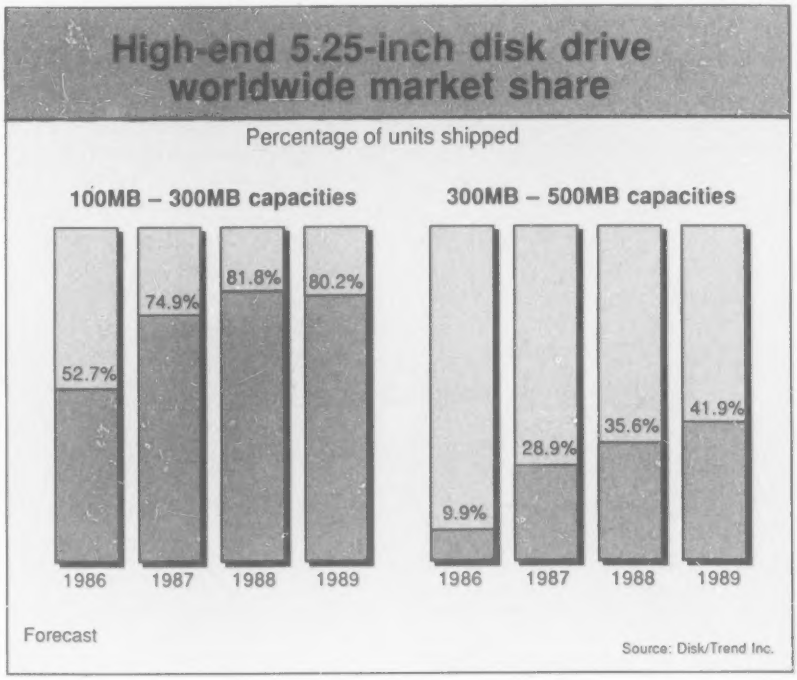
Responding to that pressure, a number of vendors are planning products to take advantage of the growth. Micropolis, Chatsworth, Calif., is currently shipping evaluation units of its 380 MB drive and has plans to ship 760 MB drives by the end of the year. Priam has announced a 380MB 5.25-inch drive that will begin shipping in quantity at the end of the summer. Quantum has not officially announced anything but hints obliquely at the possibility of a "multiple hundreds of megabytes" product due out sometime at the end of 1987 or early 1988.

Other concerns

Disk drive vendors also have to contend with a number of concerns, including format standards. The systems industry as a whole is currently in a downsizing mode. Everything from the box on the user's desk to the cost of the product has to be smaller today. And although current market technology in the 5.25-inch market is predominantly full-height, vendors are likely to turn either to half-height 5.25-inch drives or 3.5-inch drives, both of which significantly reduce the space and power requirements needed in a system box.

"Anything you can do with a half-height 5.25-inch drive you can do with a 3.5-inch drive," IDC's Vellante says. "The issues are reliability and performance and the willingness of systems vendors to go to unknown technology." Quantum currently has a half-height 5.25-inch offering in the 170MB range, and Vellante indicates that Micropolis is planning to do the same in the near future. Priam is expected to release a 3.5-inch drive sometime this year as well.

Maxtor, which will soon announce a 3.5-inch 170-MB drive, will have all the bases covered whichever way the market goes, according to Robert Teal, marketing and sales vice president. "Ultimately it comes down to which form factor will be accepted," he says. "We can always package our 3.5-inch drives as 5.25-inch half-height drives if the market never develops for 3.5-inch. If it does, then we're there."



> Digital Equipment Corp., Hewlett-Packard and IBM now reportedly all have plans to develop their own high-capacity disk drives

Another area of concern is interface standards. Currently there are three "standard" interfaces including a Seagate/IBM-compatible interface, as well as the Enhanced Small Disk Interface (ESDI) and the Small Computer System Interface (SCSI). Maxtor offers all three, but other companies, such as Quantum, are betting on the SCSI interface. As Brauchler of Quantum puts it, "there are not many really good midlevel capacity disks for just the SCSI market." Priam offers all three versions as well.

Meanwhile, 5.25-inch suppliers also realize they soon may have to contend with original equipment manufacturers, as well. Several of the largest users of 5.25-inch disk drives — including Digital Equipment Corp., Hewlett-Packard and IBM — have announced or leaked plans to develop their own high-capacity disk drives — for purely internal or merchant use, or both. This has to be unsettling to some, but Maxtor's Teal remains philosophical. "The industry hasn't changed much, and there are always two or three major companies that decide they can be disk drive manufacturers," he says. "In every one-year product cycle you can expect to lose one of your three customers this way, and you can expect to lose another of your three customers to a competitor. If you're lucky, you keep the final customer."

VALERIE RICE

At Hewlett-Packard, the word is CIM

Under Lew Platt, HP is developing a piecemeal strategy for the computer-integrated manufacturing market

By Alberto Socolovsky

Amid the functional furniture and open offices of Hewlett-Packard Co. in Palo Alto, Calif., president and chief executive John A. Young and his company's top managers periodically play host at seminars for their counterparts from other companies.

The roster of guests — top executives from firms such as AT&T, Ford Motor Co., GM Hughes Electronics Corp., Motorola Inc. — reads like a *Who's Who* of progressive management from other world-class American companies. And because every one of these firms is engaged, in one way or another, with battling foreign competition, the talk turns, naturally, to manufacturing rather than technology.

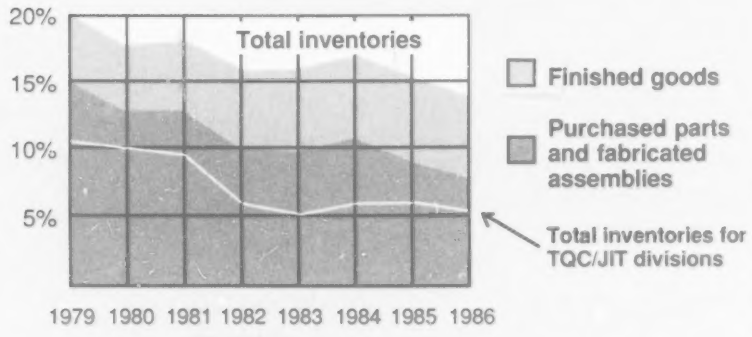
Although HP uses these seminars to promote its growing roster of computer-integrated manufacturing (CIM) products, chief executive Young first conceived the seminars — not as a vehicle to sell CIM — but to share his company's experience with other firms dealing with problems in manufacturing. Young, past chairman of the President's Commission on Industrial Competitiveness and now head of the Council on Competitiveness, believes that a competitive industrial America is good for HP. And he hopes that some of what worked for him will also work for others.

Even though many of the seminars emphasize the need for a coherent approach to implementing CIM, HP's own strategy for computer-integrated manufacturing grew out of more humble origins. Lewis E. Platt, senior vice president, says that CIM is being built piecemeal at individual divisions inside the company and involves the implementation of total quality control (TQC) to eliminate rejects and reduce rework during manufacturing. It also involves the development of just-in-time manufacturing to lower inventories. "CIM at HP consists of small steps. With TQC/JIT we got the biggest results," says Platt, a Wharton MBA, who heads a CIM task force at HP and oversees the company's own design and manufacturing, as well as the groups that make design and manufacturing systems for CIM. Through the application of TQC/JIT at several divisions, Platt says, HP has squeezed the inventory-to-sales ratio for the whole company from 20% in 1979 to 14% in 1986, and much lower for the divisions which have pioneered these applications.

Manufacturing performance alone, however, does not completely explain HP's interest in CIM. The $7 billion company also hopes to capture a major piece of the $48 billion worldwide CIM market and its $9 billion electronics segment. As head of HP's Technical Systems sector, Platt oversees the Engineering Systems Group, which makes workstations and design automation systems, and the Manufacturing Systems Group, maker of HP's automatic test equipment and computers for manufacturing. Both groups draw heavily upon HP's own design and manufacturing expertise — just as in the company's early days, when Hewlett-Packard was strictly an electronic instruments firm, designers would try their ideas and prototypes on the engineer working at the next bench. The approach eventually evolved into HP's legendary "next-bench" syndrome.

JIT and inventory management save dollars

Inventory as a percentage of revenue



Since 1979, HP has cut the cost of materials and work-in-progress inventory needed to make $1 of revenue from 15¢ to 8¢. Total inventories shrunk from 20¢ to 14¢ for the company, and from 11¢ to 6¢ for the divisions that pioneered TQC/JIT.

Source: Hewlett-Packard Company

LEW PLATT, senior vice president: "CIM at HP consists of small steps. With TQC/JIT we got the biggest results"

"Look at the 'Joey' line," recommends CIM guru Thomas G. Gunn, director of Arthur Young's National Manufacturing Consulting Group. Joey, the code name for HP's low-cost ColorPro plotter, was the first application of JIT at the company's San Diego plant. The entire assembly line for this plotter — from the insertion of components on printed circuit boards (PCBs) to final test — fits into a fenced area of less than 10,000 square feet. Joey is a high volume — one million-plus plotters a year — yet flexible line, says Gunn, "through which go 50 different models, some of them in lot sizes of one. The line was designed for over 60 inventory turns in a year, direct labor is less than 1% of product cost."

"Joey is a factory within a factory. JIT, [and] the information systems and the materials handling [which support it] were designed specifically for that product," explains Brian B. Moore, former manager of the San Diego plant who now reports to Platt as general manager of the Manufacturing Systems Group. "It represents the [CIM] approach we recommend [at our executive seminars] — starting small, [and in] a logical progression. My group is starting to market this experience." In that sense, he agrees, HP's CIM development follows the "next-factory" syndrome. "We don't claim to have a $250 million CIM showcase like IBM's Lexington, Ky., [electronic typewriter] factory. Our customers feel a lot more comfortable when they go to San Diego and see results for less than $1 million."

Moore's group makes HP's highly regarded automatic circuit board testers and the popular HP1000 computers (widely used in manufacturing within the company, as well as by its customers, to control an area of workcells). These successful products serve as the beachhead for marketing the CIM experience, as well the group's latest computers: HP's powerful new "precision architecture" (previously code-named Spectrum) machines which are based on reduced instruction set computing.

JIT tours

But to market CIM Platt needs to do more than just show how HP's "think big but start small" approach works at its own factories. "CIM can't succeed without commitment from the top," he asserts. "You need the president [of your customer's company] to be committed to TQC/JIT."

Reg Francklyn

Therefore, he values HP's executive seminars as a marketing tool for CIM; especially the informal discussions at the end of each session. And, he says, "I can think of lots of pieces of business that came out of those discussions."

There is another plus to HP's executive seminars. "The CEO or VP of operations who attends sends a manufacturing VP or production manager for a one-and-a-half day seminar just on manufacturing, or an engineering manager for a design seminar. No charge," Platt says.

Indeed, many of the guests do follow up and send their manufacturing and materials managers to visit HP plants that have implemented TQC/JIT. They also attend the manufacturing seminars that several of these plants conduct. Visitors see gas chromatographs made in Avondale, Pa.; printers in Boise, Idaho, and Vancouver, Wash.; workstations and small Winchester disk drives in Fort Collins, and Greeley, Colo., respectively; instruments in Lake Stevens, Wash., and Rockaway, N.J.; and X-Y color plotters in San Diego. At each plant, the products and the manufacturing steps are different but the reports are similar. HP plant managers take pride in telling how, in the past three years, the piecemeal application of TQC and JIT has increased productivity, multiplied inventory turns, improved quality, reduced warranty costs, saved manufacturing space, and even reduced receivables.

BRIAN MOORE, general manager, Manufacturing Systems Group: "We don't claim to have a $250 million CIM showcase like IBM's Lexington, Ky., [electronic typewriter] factory"

JIT itself is implemented piecemeal. "Don't think of JIT as trucks coming into our dock. Before going to any outside vendors, we put JIT in place within our own factory," says Tom Viola, manufacturing engineering manager of the Fort Collins Systems Division, which builds the HP9000 32-bit workstations. "After we took 40 types of PC boards and merged them, we didn't have to build any boards for three months." Viola and his colleagues emphasize that they have not yet tackled CIM, but are continuously improving the process by adding, still in piecemeal fashion, more steps toward CIM implementation. Predictably, they plan to use more HP computers, particularly the new precision architecture machines.

"I've been very pleased with HP's progress in JIT manufacturing," says Burnham Casterline, a Motorola vice president and director for manufacturing, who first introduced JIT in the manufacture of cellular mobile telephones, a leading Motorola product that faces fierce competition from Japan. Calling JIT "the entry point" for CIM, Casterline keeps tabs on HP's steps. A good customer — "we've had a fine relationship with HP for two years, buying instruments and test equipment," he says.

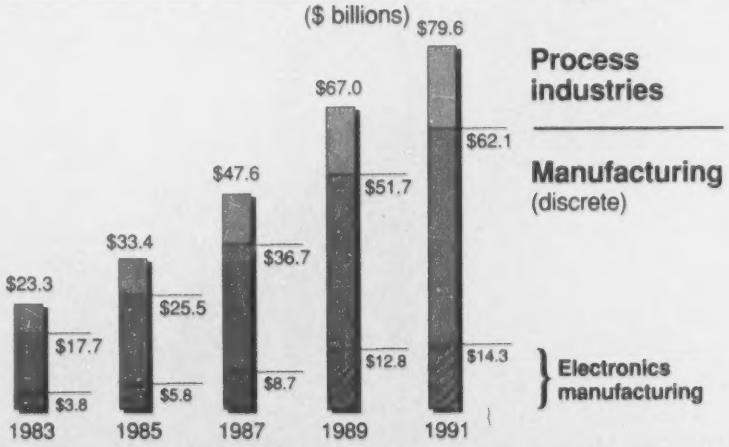
Casterline has also attended manufacturing seminars at several HP plants. So has John Lee, director for inventory management at McDonnell Douglas Computer Systems Co., the manufacturing arm of the large aerospace corporation's Information Systems Group. Lee does not claim to buy a lot from HP, "although the [company's] aerospace group does. I've three [Factron] Schlumberger board testers," and adds that he is unlikely to buy any more or any less, as a result of attending the seminars. But he attended them because, through a JIT consultant, who had previously worked at HP, "we were aware that the Fort Collins and Greeley plants were living models of what we're trying to do," says Lee.

Taking on IBM and DEC

To succeed in CIM, however, Hewlett-Packard must beat the same formidable rivals it has faced all along in the computer market: IBM and Digital Equipment Corp. IBM and DEC are the worldwide leaders in CIM (for all applications, including discrete and process manufacturing), with $3.5 billion and $2.3 billion in CIM sales, respectively, in 1986, according to Julius Dorfman, president of CIMdata. The Wellesley Hills, Mass., market researcher places HP as a distant third with $900 million, followed by General Electric Co., Intergraph Corp. and Computervision Corp. For electronics applications, the lineup of the top three is the same, says Dorfman, saying that electronics manufacturing accounts for almost 20% of the total market — but probably represents a larger share of the total CIM sales for DEC and HP than it does for Big Blue.

"The only three computer vendors

Worldwide market for CIM



Of every five CIM dollars, four are spent for discrete manufacturing (as in autos), one for process industries (chemicals, food, petroleum). Today CIM for electronics represents 23% of discrete manufacturing.

Source: CIMdata

worth talking about in CIM are IBM, DEC and HP," agrees Glen Allmendinger, president of Harbor Research. The management consultant from Cambridge, Mass., who specializes in CIM and industrial automation, says that IBM's lead harks back to its clout in management information systems; and DEC's place, to its large installed base of computers in manufacturing. "HP has computers in many businesses but can't point to any area where they lead," he says. But Allmendinger adds that HP has an opportunity to increase its share because recently it has been promoting CIM far more actively than its larger competitors. "They're bringing in highly refined tools, such as common user interfaces and applications generators."

Allmendinger is not alone, however, in his concerns about HP's ability to penetrate CIM accounts in areas outside of its traditional base of electronics manufacturers. Analyst Laura Conigliaro, for example, thinks the company will succeed in the electronics industry "where it has a loyal legion of users, and HP has provided good support." But, warns the senior vice president from Prudential-Bache Securities Inc., "I'd hate to see them take an industrial project in the rust bowl!"

In a way, the strategies by both IBM and DEC resemble HP's next-factory syndrome. Big Blue's catalog of software and hardware products for CIM states that "as a manufacturer, IBM is implementing its own CIM strategy to reduce costs, improve quality and enhance market responsiveness. As a vendor, IBM is committed to provide products and support in the CIM environment so that our customers can, likewise, realize these benefits and respond to business need." DEC also offers CIM solutions developed at its own factories, all of them based on its popular VAX computer and networking architecture, but recently it has expanded the VAX family to handle real-time applications and has entered into cooperative agreements with Honeywell Micro Switch and Rexnord Corp. in the CIM market.

TOM VIOLA, manufacturing engineering manager, Fort Collins Systems Division: "Don't think of JIT as trucks coming into our dock. Before going to any outside vendors, we put JIT in place at our own factory"

Hewlett-Packard, however, is not waging this battle against IBM and DEC alone. It is also bringing in outside help. Recently, HP has been enlisting the help of third parties, or "value-added (V-A) channels," as the company prefers to call them. Actually, HP uses this term very broadly, because it already credits V-A channels for almost $1.9 billion worth of revenue in 1986 — one-third of its equipment sales. This is because one of the channels — original equipment manufacturers (OEMs) that build electronic systems incorporating HP computers and/or instruments — predates the CIM market by more than a decade. The OEM base consists of companies such as Gerber Scientific Inc., Measurex Corp. and Scitex Corporation Ltd., that have been building systems for CAD, the paper industry and cartographers, respectively.

On the other hand, HP credits systems integrators — which contribute both hardware and software — and software developers, for most of its CIM sales, which CIMdata estimates at $900 million in 1986. Both channels require a lot of support and close cooperation from the hardware vendor, something which only three years ago HP was not keen in providing. Moreover, HP has its own in-house systems integrator, the Advanced Manufacturing Systems Operation, which draws as much as possible on HP's products to implement custom solutions.

"We used to call [the third parties] a pain in the neck," admits Platt. "No longer. We went on to [call them] a necessary evil. Now they're an important part of our strategy." Platt's Technical Systems sector now even has a manager who works with value-added channels, and looks to them for help in penetrating nonelectronics applications. "HP knows a fair amount about electronics," asserts Moore. "But we don't know a whole lot about everybody else's process and their industries. We look on our value-added partners — all those people from which our customers can get help — as pretty important." A third, and increasingly important value-added channel consists of management consultancies such as Arthur Young, Coopers & Lybrand and Harbor Research. Although their value to HP centered in their influence in educating potential clients, AY and C&L have also set

HP's road map to TQC/JIT

Total Quality Control (TQC) process

- Commitment to continuous improvement
- Gather failure data
- Establish clear responsibility for action
- Provide feedback of data
- Drive the "PDCA circle" several times
  - P: Plan to solve a problem
  - D: Do analysis
  - C: Check effectiveness
  - A: Take Action, such as setting standards
- Use statistical quality control as a tool

Just In Time rids manufacturing of waste

- Reduce inventories
- Eliminate quality rejects
- Reduce lot sizes
- Reduce setup times
- Reduce throughput times
- Improve maintenance
- Simplify the process
- Total involvement (of people) at all levels

Source: Hewlett-Packard, Fort Collins Systems Division

ROBOTIZED ASSEMBLY STATIONS for odd-size ICs at HP's Fort Collins Systems Division

up CIM operations which function as systems integrators, says HP's value-added channels manager Steve Haslett.

Adding value in electronics

The value-adders seem to be just as important to HP in electronics manufacturing. The main reason is that electronics customers buy computers from more than one vendor. "HP doesn't sell DEC computers," says Paul Paquette, a manager for the Dynamac division of CIM systems integrator American Cimflex Corp. "The reason they're in CIM is they want to sell computers, whereas we are in CIM because we want to solve customers' problems. At the [manufacturing] area-manager level, depending on the plant's standards, the computer could be HP, DEC, or IBM."

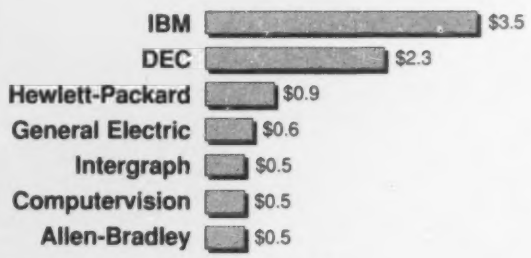
That kind of situation also exists at the Bramalea plant of Northern Telecom Canada Ltd., near Toronto, which makes line cards for the Digital Switching Division of the Canadian telecommunications giant. Richard Lue, manager for flexible manufacturing systems, says IBM PCs and HP150 microcomputers control individual workcells such as robots, automatic insertion machines and solder paste applicators. "The overall manufacturing process is driven by an HP1000," says Lue, "and we've worked closely with HP. But we have a couple of IBM hosts which store the design information and the business-operation data, such as order entry and work-in-process tracking." Denniston & Denniston Inc., a value-added partner of HP, is also developing the software to link the different levels and provide each cell with access to the data. "One station may have design data; another, inspection; a third one, wave-soldering information. We treat them as individual cells."

At Northern Telecom's U.S. operation in Raleigh, N.C., Hans Berger, director for advanced manufacturing automation, runs a line that makes similar line cards. But the line is three times larger than the Canadian line and uses HP's computers, including an HP3000 host for the management information system. "With our production volumes, we can justify more sophisticated levels of process control. [Going with HP computers] was the correct decision three years ago, I don't know what the decision would be today," says Berger. Writing the software was a joint project. "We wrote some, HP wrote some, the third party wrote some," says Berger.

Dynacam, the systems integrator that developed special pallets and other materials-handling equipment that tie together the robotic and component insertion workcells at Northern Telecom's Raleigh plant, is already cooperating with HP on a potentially larger project for the Electrical and Electronics Division (EED) of Ford Motor Co. Dynacam's parent, American Cimflex, along with Hewlett-Packard, Industrial Networking Inc., and Motorola's Microcomputer Division, cooperated in a

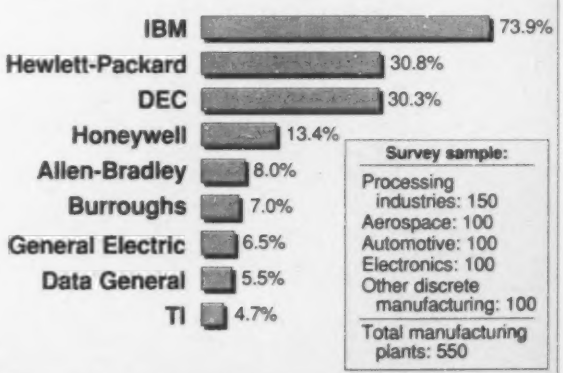
Leading CIM vendors

1986 worldwide sales, all applications ($ billions)



Source: CIMdata

HP asked who's who in CIM



Results of an awareness survey conducted by HP among 550 manufacturing plants, in November 1985

pilot installation of the manufacturing automation protocol (MAP) at EED's plant in Rawsonville, Mich. "Teamwork is responsible for the steady progress we've made," says Robert M. Pearson, EED's manager for advanced manufacturing. In addition, the team is gearing up to participate in the automation of another of EED's electronics plants in Lansdale, Pa., thus helping HP in its goal to be a major supplier of CIM to the U.S. automotive industry.

Last September, HP Engineering Systems Group (ESG) also became part of Platt's Technical Sector. William G. Parzybok Jr., a company vice president, who is the group's general manager, says ESG's strategy rests on the HP9000, a general-purpose computing platform that is driven by industry standards such as the Unix operating system. As is the case with Moore's Manufacturing Systems Group, Parzybok's strategy includes value-adders, such as independent software vendors (ISVs) and OEMs, to penetrate unfamiliar markets.

For Motorola, an HP partner and supplier of the 68000-series microprocessors that ESG uses in the HP9000, the platform is solid. "Because [the 32-bit 9000-320 offers] Unix, it's an ideal vehicle to tie our different areas; first assembly, where your own 32-bit Delta computer controls the stations; then test, where we have several HP3065 board testers," says Richard T. Kelly, test engineering manager of Motorola's Microcomputer Division. In another 18 months to two years, says Kelly, his division will link design with assembly. "We'll download schematics and assembly drawings and display them in the production area." This, adds Kelly, combined with a 2-year-old JIT effort, will help his division meet Motorola's "6-sigma" project (less than 36 ppm) which aims essentially at zero defects, or total customer satisfaction.

Selling CIM

Although value-added channels can help HP in penetrating CIM accounts, the job of selling still rests largely on HP's highly regarded infantry — its salesforce. However, because CIM solutions cut across several product lines, HP had to reorganize its salesforce three years ago so that at the local level, according to Platt, "the [sales] organizations report to a single individual."

"Selling CIM is one of the most complicated processes at HP," says Richard K. Ellinger, sales manager of

AT A GLANCE

Hewlett-Packard Co.
Palo Alto, Calif.

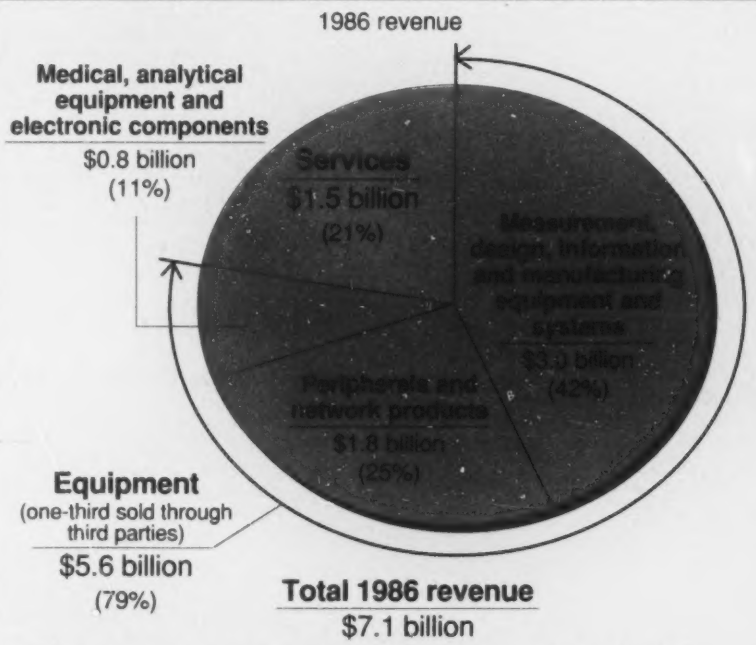
	FISCAL YEAR COMPARISON		
	1986	**1985**	**Change**
Sales ($ millions)	$7,102	$6,505	+9.2%
Net income ($ millions)	$516	$489	+5.5%
Net income/sales	7.3%	7.5%	–
Cost of sales/sales	47.2%	48.7%	–
R&D/sales	11.6%	10.5%	–
Marketing, G&A/sales	19.7%	18.2%	–
Capital expenditures/sales	7.0%	9.7%	–
Number of employees	82,000	84,000	-2.4%
Sales per employee	$86,610	$77,440	-11.8%
Net income per employee	$6,293	$5,821	+8.1%
Current ratio	2.51	2.43	+3.4%
Debt/equity ratio	0.0251	0.0256	-1.8%

Fiscal year ending October 31,

	MOST RECENT THREE MONTHS		
	1987	**1986**	**Change**
Sales ($ millions)	$1,740	$1,597	+9.0%
Net income ($ millions)	$116	$109	+6.4%

Three months ending January 31,

Third parties are first for HP in CIM



Third parties, or value-added channels, accounted for almost one-third (more than $2 billion) of HP's equipment sales. Value-adders involved in CIM must have accounted for most of HP's CIM sales, which CIMdata puts at $900 million for 1986.

Source: Hewlett-Packard

design and manufacturing systems. "You don't see many cases where [the demand for CIM] is driven by management, as in the case of GM. Usually, we deal with a manufacturer who has two-dimensional drafting, incoming inspection and manufacturing test, often from different vendors and installed at different times. In that case, we ask our salespeople to go in and make a mental road map of the process flow, or a transfer diagram of the machinery, and look for things that can be done better with MRP and JIT, which are flow-related." The salespeople must figure out the customer's highest priorities, even if the customer himself doesn't know them yet. In sum, an HP salesperson acts as consultant in manufacturing, communications networks, test, quality control and production variable analysis. "Sometimes, with key selected customers, John Young will invite their key executives to the executive seminar," adds Ellinger.

This brings the CIM sales job back to HP's top executives, underscoring what Platt and others at HP have been saying all along: implementing CIM is a big commitment, and it will never happen without a big commitment from the top. □

There's a software quality to John Young's memo

Much of what Hewlett-Packard Co. has to tell — and hopes to sell — about making quality hardware can be traced to a challenge John Young issued verbally to the company's managers at the beginning of this decade. Chief executive Young said that he wanted a tenfold reduction in failure rates of HP's hardware during the 1980s.

Today the company is well on its way to fulfill the boss' goal. But now Young is trying for an encore with software. And this time, he put the challenge in writing.

The hardware challenge stemmed from a study Young commissioned in the late 1970s to examine the impact on manufacturing costs of less than perfect quality. Company records showed that warranty costs were 2% of sales, but he was not satisfied with that answer. "He redefined the whole concept of cost of quality," recalls senior vice president Lewis E. Platt, "[to include all] rework and a lot of testing steps." Calculated that way, quality problems turned out to account for 25% of total costs.

"Well, that stirred John up," recalls Platt. "Most of us who were at the general management meeting [attended by HP's top 100 managers] in 1980 will remember the outcome. Addressing a bunch of people who had every reason to believe they were managing one of the highest quality companies in the world, he said: that wouldn't be enough. 'We're going to need an order of magnitude improvement in our failure rates during the decade of the 80s to remain competitive,' [Young said]." Platt admits that the first reaction was somewhat incredulous. "Was he serious? [Some people thought] he probably wanted to get a factor of two, but figured he'd have to ask for 10 ... to get two."

Young, however, was serious. "[His goal] was such a challenge," says Platt, "that you couldn't [meet it just by making] a few changes. Quality projects sprang up everywhere. People got serious about TQC." To quantify the goal, the managers devised a definition to measure failure rate: The number of failures in the first 105 days after shipment divided by shipment dollars. "It's very clear that we will achieve [10 times reduction by 1989]," reports Platt. "Some divisions are talking about factors of 12 and 15."

JOHN YOUNG, chief executive, encouraged by the response to his challenge to improve hardware quality, is now trying for an encore with software

Improvements in quality carry over to the bottom line, explains Platt, as inventories go down as a percentage of sales, manufacturing cycle times shrink, and even receivables from customers decline (from 62 days in 1979 to 53 in 1986). "People don't mind paying on time when they get the right product and it works," says Platt.

Kill the cute bugs

Encouraged by the response to his challenge on hardware, Young has extended it to software. "We need similar gains in the quality of our software products to achieve the same excellent reputation for quality that our hardware products have earned," he wrote in a memo to management in April of 1986. But this time he shortened the lead-time, and he, himself, defined how to measure the goal. "I want us to achieve a tenfold improvement in two key software quality measures in the next five years," wrote Young. "The first is aimed at our design process; the second at our ability to solve problems once customers have our products in place." The first measurement (post-release defect density) is the total number of known problem reports (KPRs) during the first year after initial shipment release, divided by the number of units shipped in that year. The second measurement (open critical and serious KPRs) is the number of unfixed KPRs classified as critical or serious by customers, reported monthly.

Although it is still too early to measure the improvement, Platt reports that the company's quality managers are starting by changing their vocabulary. "We don't call things that don't work in software 'bugs' anymore. Bugs [sounds like] a cute term. We call them 'software defects' today. Amazing what a change in words will do. Software defects [are] not as cute as a bug, they can be attacked just as systematically as hardware defects would be." □

Beckman Industrial shows some marketing muscle

If you've got it, flaunt it. That's how Beckman plans to gain market share in the resistant resistor market

By John Kerr

There was a time when Beckman Industrial Corp.'s Electronic Technologies Division (BI-ETD) apparently believed that competing meant never having to say you were there.

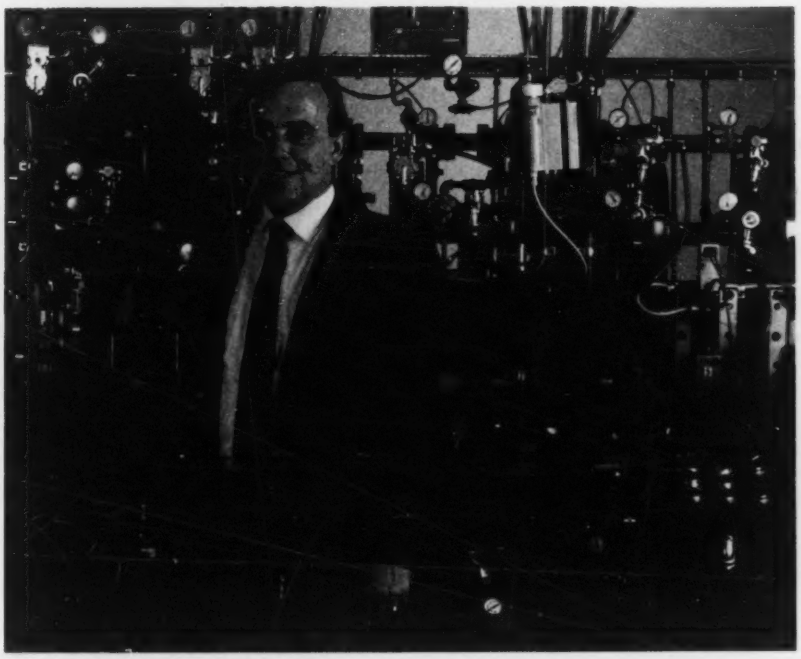
The Fullerton, California-based resistive-products maker would not advertise its wares. It shrank from publicity. This at a time when archrival Bourns Inc. was piling on the marketing pizzazz — and when resistor sales were congealing.

That promotional pallor prevailed long after Emerson Electric Co. bought BI-ETD from SmithKline Beckman Corp. in 1984. The unit drifted without a national sales manager for three months and without a distributor-sales chief for six months. "It looked like they were in the doldrums," says a competitor.

That is beginning to change. Under demanding new Emerson management, the division is getting a facelift. A number of new executives are now in place as Emerson veteran Dennis Moore, BI-ETD's president since February 1986, begins to make marketing more of a priority at the once publicity-shy outfit. "We need the visibility; in terms of industry awareness and customer awareness, you can't have too much," he maintains. At the same time, manufacturing facilities are getting a makeover: over $20 million has recently gone into new equipment and buildings.

The statistics suggest that Moore has a tough task ahead. In a market now experiencing excess production capacities, continual pricing pressure and only a meager uptick in demand, it will take exceptional efforts to do much for Beckman's undisclosed profits, which, although up last year, remain marginal.

Moore is undeterred. "We're doing less awfully than the others," Moore quips. His goals are annual revenue growth of 10% to 15% and operating margins that approach the Emerson ideal of 15%. But he admits that those profitability levels are out of reach for at least two years.



EMERSON VETERAN DENNIS MOORE has been recruited to insert some vitality into Beckman's industrial plan

Robert Burroughs

Beckman traces its origin back to 1940, when founder Arnold Beckman invented the first multiturn precision potentiometer. Today about 35% of the division's $90 million-plus in sales comes from trimming potentiometers, also known as trimmers. The rest is portioned evenly among resistor networks; precision components, such as potentiometers and turns-counting dials; and hybrid microcircuits.

Beckman claims market leadership in precision pots and dials and the No. 2 slot behind Bourns in trimmers. Networks, where it ranks fourth, are the division's fastest growth sector and should rival trimmers as its major product area by 1990.

But, it is hard to become delirious about future prospects when the pundits say the market for your hottest product will be lucky if it experiences more than a 6% annual growth rate. Gnostic Concepts Inc., a San Mateo, Calif., market research firm, projects that U.S. original equipment manufacturer (OEM) consumption of networks, valued at $183 million for 1986, will inch up to only $238 million by 1990.

This is dynamite compared with the trimmer sector, which Gnostic estimates will drag from $148 million in 1986 to $154 million in 1990, and compared with the OEM resistive-products market as a whole, averaging only 2.4% annual growth to reach $1.091 million by 1990. Distributor sales are unlikely to do better. "There are no barn-burners right now," sighs

Ray Allen, Beckman's resistive-products marketing manager.

Worse: despite shortages and lead-time stretch-outs in many resistor lines, customers still want to drive prices down. Although trimmer prices appear to be stabilizing, other sectors are still headed south: Gnostic forecasts a 7% annual slide in network prices.

Beckman has seen better times; the division enjoyed a bumper year in 1984. But not so in recent years as the computer slowdown began and other customers reassessed parts inventories. In fiscal 1985 (ended Sept. 30), BI-ETD was marginally profitable. For fiscal 1986, it barely broke even. Compared with overall performance at its Emerson parent, which netted $409 million on $4.95 billion in sales to make 1986 its 29th consecutive year of increased earnings, BI-ETD's results look shabby.

Moore on more

Luckily, Emerson is more interested in Beckman's future improvements than in past performance. Although they retain the luxury of autonomy, Beckman executives cite a key difference in the way their new parent manages: where SmithKline mandarins focused loosely on what had — or had not — been achieved, Emerson demands excruciatingly detailed plans outlining how performance will be bettered.

Moore has those plans in place. His recovery program touches most bases: manufacturing, quality, product and marketing. The overall aim is to improve customer responsiveness, which includes development of just-in-time manufacturing and ship-to-stock programs for major OEMs. "The customer is king — that's the message I keep giving people," says Moore.

FOUNDER ARNOLD BECKMAN invented the first multiturn precision potentiometer, or trimmer

He is lucky to be able to build on a $20 million-plus investment in plant and equipment by Emerson. A new building houses high-volume production lines for microcircuits and networks. Other expenditures included: final assembly machines for trimmers and networks; automated wire bonders for microcircuits; and high-speed winding machines for precision components. The division is also promoting statistical process control to help cut trimmer production costs. And emphasis continues on what observers rate Beckman highly for: product quality. A new quality-assurance manager is on board, and two network lines already run below 100 defective parts per million (ppm). But there is no room for complacency: rival Bourns says that it means to hit 10 ppm by 1990.

The manufacturing push appears to be working. One distributor reports that some of Beckman's conformal-coated resistive product. — polymer-coated components which are more economical and more flexible than molded resistors — easily beat Japanese imports on quality, price and performance.

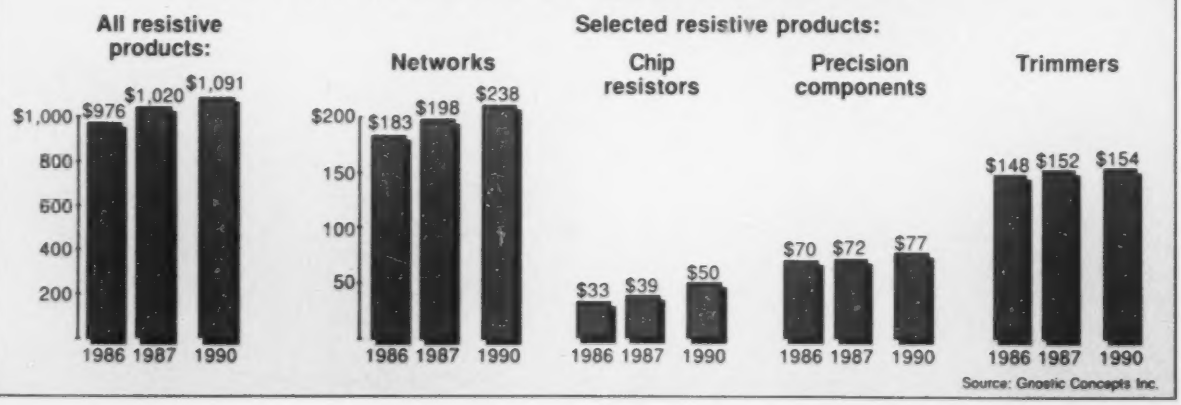
Product offerings are also being broadened. The emphasis is on filling gaps in the trimmer lineup. A square quarter-inch multiturn unit makes its debut this month; other products are being redesigned for automation, or packaged in tape reels for users' machine insertion. In hybrid microcircuits, the race is on to get new products certified to the MIL-SPEC 1772 military specification that will soon become a standard.

Beckman is also responding — more cautiously than some of its competitors — to seminal demand for surface-mounted devices (SMDs), a market that so far has defied forecasters who said that 40% of resistive products sold by 1990 would be SMDs. "We're skeptical it'll be that high," says Moore. BI-ETD's new Model 632 Dense Pack network typifies the trend: it crams 36 resistors into a single 20-lead square molded package.

Product advances owe much to Beckman's top-notch analytical laboratory, claims Moore. He points out that progress in resistors relies less on electronics know-how than on innova-

Beckman's key product sectors still look sticky

U.S. OEM consumption of U.S.-produced equipment ($ millions)



Source: Gnostic Concepts Inc.

tive application of materials like conductive plastics.

On the marketing front, Moore has hired two ex-Bourns executives with cast-iron reputations. Together, national sales manager Robert Sickler and distributor sales manager Edward Palwick are putting some magic back into marketing. "Bourns has done a very good job. We're really running to catch up," concedes Sickler.

He has introduced a "Focus Account Program" that ensures slavish attention to the needs of the dozen customers that provide the bulk of Beckman's OEM sales. And he has sent regional sales managers to their territories; under SmithKline, they attempted to cover America from headquarters.

Distributor sales — about 40% of total sales — are getting the treatment, too. BI-ETD has trimmed its distributor locations from about 220 to around 200 nationwide, eliminating one national — Time Electronics, a division of Avnet Inc. — and four regionals, and adding three local distributors that show less inclination to be distracted by sexier semiconductor sales. "Our orientation has to be toward those distributors who are equipped to sell and interested in selling passives," explains Sickler.

Other distributor support includes getting Beckman's regional managers to work with their distributor counterparts and tightly focused quarterly planning sessions for the representatives Beckman uses. "We've been working a lot closer with our distributors to help them manage their inventory levels," adds Moore.

Beckman is also intent on holding prices firm, even though price erosion in its product ranges is still uncomfortably steep. Under tighter pricing-authority levels, BI-ETD salespeople must clear even the smaller orders with their managers if deep discounts are demanded. The rationale is that no matter how tempting it may be to follow the pricing spiral downward in a bid to fill up the factory, the brakes must be applied for the long-term good of the industry.

This policy has already cost Beckman plenty. A peripherals maker with a $450,000 order to place recently demanded a 20% discount. Beckman declined, but got 25% of the business anyway at slightly higher prices. It also shunned $85,000 in telecommunications business when required to drop prices another 12%.

Distributors love the new Beckman. Says Michael Mills, corporate marketing manager for passive and electromechanical components at Kierulff Electronics: "They're good strong supporters of distribution. They've implemented some very innovative programs." Arrow Electronics Inc. is similarly impressed — enough to double its inventory of Beckman parts.

But market-share jostling will only take Beckman so far. Ultimately, its welfare depends on upturn in the fortunes of its users. Early in 1987, BI-ETD was seeing some pickup at manufacturers of power supplies, computers and peripherals, but nothing from instrumentation. Moore foresees little or no growth in trimmers this year, with perhaps 10% in networks and in microcircuits for the military.

Farther out, Moore pins more hope on budding Far East markets. "We're in the business for the long term," he insists. □

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How CFOs view the Tax Reform Act of 1986

The electronics industry may profit from reform, but the economy will suffer, some CFOs claim in an exclusive poll

By Bruce C.P. Rayner

For chief financial officers and vice presidents for finance, the most common complaint about tax reform is that it makes tax planning more uncertain. While the Internal Revenue Service cranks out explanations and updates of explanations concerning the new legislation, accountants are scrambling to get up to speed on the new bill so they can advise their clients.

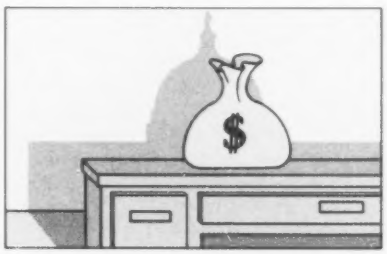
"From the point of view of the corporate taxpayer things certainly didn't get simpler. They got more complicated," says John Rogers, chief financial officer at Zytec Corp., a $50 million power supply maker based in Minneapolis. The problem now is how do companies deal with the added complexity and increased uncertainty?

Besides the key components of tax reform — including the repeal of the investment tax credit (ITC), the higher capital gains tax rate and the lower corporate tax rate — there are many aspects of the new bill that are certain to influence corporate decision making. Affected are corporate structure, employee compensation packages, leasing arrangements and international business practices.

"Every day I read something new [about the tax act] that I didn't know before," comments William Whitehead, vice president for finance at Vectran Corp. a Pittsburgh-based maker of radio data terminals used in real-time warehousing and inventory control. Whitehead complains that because it is so hard to get all the facts, much of the bill is still up for interpretation, "It is going to be more complicated for individuals and will create additional costs for businesses."

But, despite the added uncertainty and the fact that industry must bear the brunt of revenue generation under tax reform, many chief financial officers in the electronics industry believe the short-term effects of tax reform will be minimal. This optimistic outlook implies that financial executives expect the good to outweigh the bad.

This optimism was reflected in a recent poll, conducted by ELECTRONIC BUSINESS, of 73 chief financial officers, vice presidents for finance and controllers. Of those surveyed, 57% came from companies with under $20 million in sales for 1986.



The key components of tax reform for high tech include repeal of the investment tax credit, higher capital gains and a lower corporate tax rate

Surprisingly, over 50% of the respondents expect their corporate after-tax profits to increase in 1988, 1989 and 1990. At the same time, 77% believe that economy-wide capital spending will decrease, and 45% think the federal budget deficit will get worse.

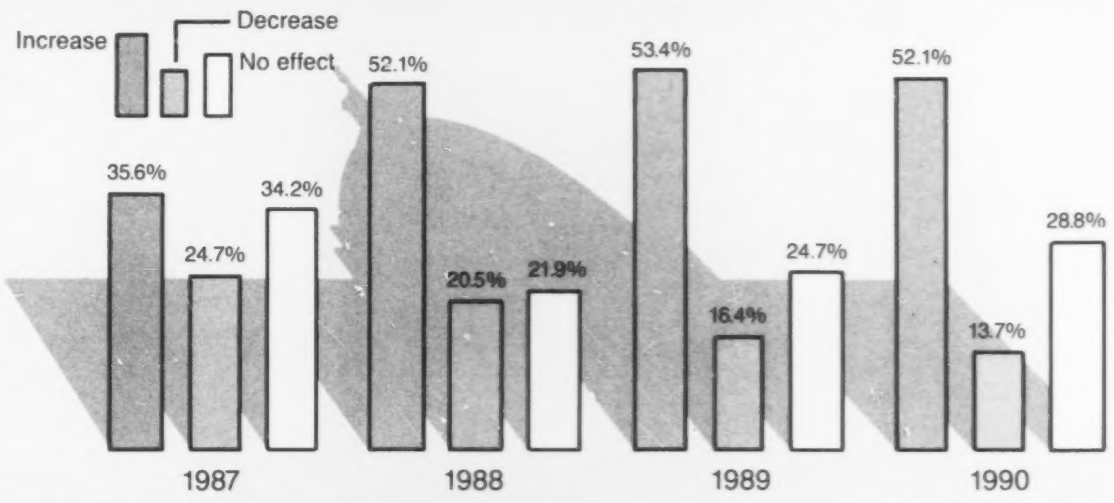
The consensus of those surveyed was that the lower corporate tax rate and the extension of the research and experimentation (R&E) tax credit are the most tangible benefits of tax reform for high-tech companies. Respondents also agreed that the stretching out of depreciation schedules for some equipment and the repeal of the ITC will be the most damaging to corporate health. Two other major changes in the tax code — the increase in the capital gains tax rate from 20% to 28% and the changes in relative international tax rates — are not expected to affect electronics companies one way or the other, respondents said.

The AMT complex

One source of added complexity in the new bill is the calculation of the alternative minimum tax (AMT), a 20% tax on income, plus certain deductibles, deferrals and tax preferences that a corporation is required to pay if it exceeds the regular tax calculation. This new provision also requires corporations to keep an additional set of books. Despite the adverse effects the AMT is expected to have, 60% of the respondents said the AMT will have a neutral impact on their companies, and only 29% said it would have a negative effect.

Harvey Fireman, senior tax manager at Ernst & Whinney, a Big Eight accounting firm, calls the AMT a "pervasive change" in the tax code. "Just by the nature of having to keep a separate set of books for alternative minimum taxable income is just enormously complex," Fireman says. Nearly 51% of respondents said the AMT will increase the number of man-hours needed to calculate the additional tax, but only 27% expect the

The Tax Reform Act of 1986 will generally have what overall result on your company's net after-tax profits in the following calendar years?



For 1987, 57% of all industrial-based computer systems companies expect their profits to decline as a result of tax reform, while 83% of the semiconductor manufacturers surveyed expect no change.

AMT to increase their tax burden.

Fernando Sanchez, controller, manufacturing operations, at Racal-Milgo Inc., a Sunrise, Florida-based maker of communications equipment, says that his company has done some preliminary studies but nothing is conclusive yet. The AMT calculation is going to require more administrative work, he says, but it is uncertain if there is going to be any impact on the company's tax burden. "You can talk to three experts and get five different opinions," he quips.

Abe Schneier, legislative representative for the National Federation of Independent Business, agrees the AMT introduces added uncertainty and complexity. Most smaller firms do not know what it means yet, and so many of them are not even planning for the AMT, he says. Even though the new legislation is in place, the rules are still being debated, making long-term planning impossible.

More than anything else, Schneier comments, the increased record-keeping burden is extremely unfair to smaller businesses. One financial vice president of a small West Coast start-up company says that he still does not know what the AMT means for his business. He said, prior to filing, that he will probably pay someone else to calculate it when the time comes.

"The clerical effort is going to be increased as a result [of the AMT], there is no doubt about that," says Kevin Walsh, controller of the Schlumberger Computer Aided Systems (CAS) group of Schlumberger Ltd. He scoffs at the notion that tax simplification was once one of the objectives of the new legislation.

No one else is laughing either. "The AMT may very well take away some of the tax benefits that we were looking at as perhaps the only silver lining of having had a loss in one year," says Rogers of Zytec, a 3-year-old company that earlier had suffered through some tough financial times. "We might have to pay, or pay more than we otherwise might have done," he adds. As for the added man-hours required to calculate the AMT, Rogers comments that, because Zytec does not have a big staff, adding a couple hundred hours of work will be a costly and painful process.

S corporation deflated

One structural change that could have a significant effect on the revenue-generating potential of tax reform is the decision by closely held corporations to opt for S corporation status. Under this corporate form, the AMT is not applicable and income is taxed only once at the shareholder level. Also, with the repeal of the General Utilities doctrine — requiring liquidating corporations to pay tax on the distribution of appreciated property — S corporation status becomes more appealing.

Toward the end of 1986, when accountants were recommending that clients look at adopting S corporation status, many expected a surge in the conversion rate. But the stampede never materialized — or at least there is no documentation to indicate that it happened. The hesitancy was put down to the uncertainty in the market.

Only 15% of those surveyed said that they considered some form of restructuring in 1986. Of that number, 9% actually adopted S corporation status and another 9% opted for a Master Limited Partnership. An MLP is a reconfiguration of a corporation to make the investors shareholders and any income generated becomes taxable at the lower personal tax rate. Although more complex and time consuming to arrange, the MLP structure will become more popular in the future, says Fireman of Ernst & Whinney. The Boston Celtics basketball team is an MPL.

Another 55% of those that considered restructuring in 1986 said they would consider a change in either 1987 or 1988. Extrapolating from these results, S corporations or MLPs will no doubt become more numerous. The implications of what this means for generating federal tax revenue, however, remain unclear. But it could mean that revenue neutrality, as projected by Congress, might be less likely.

Whitehead of Vectran says that his company considered S corporation status but has not acted on it yet, partly because the regulations are still "up in the air." He says Vectran will look at it again down the road when

the tax rules are clearer. An added bonus of S corporation status, Whitehead points out, is that it is as equally applicable to state income tax as it is to federal income tax. In Pennsylvania, where Vectran is located and where the difference between the corporate income tax rate and the individual tax rate was over 7% in 1986, the advantages of S corporation status need little justification.

Effect on leasing

For those that lease plant and equipment, the cost of leasing is expected to increase because of the repeal of the ITC and the possible rise in interest rates later this year. Two-thirds of those surveyed said that they leased plant and equipment in 1986, and most of them are not anticipating any change in their leasing activity in the near term. This is because most leasing contracts are long term in nature and are based on economic contraints, rather than tax considerations. The higher cost of leasing will either be absorbed or passed on to customers.

For a company like Racal-Milgo, which does a substantial amount of its business in leasing equipment, a static change like tax reform will cause changes only after one or two years, says controller Sanchez. Because of the structure of the tax code in the past, Racal-Milgo was able to record the depreciation against the lease income for tax purposes and therefore report losses. Until the lease base is large enough to cover the overhead, he says, Racal-Milgo will continue to report to the IRS in this fashion. But Sanchez fears the possible adverse effects the AMT will have on the company's growing lease business.

Schlumberger's Walsh does not see tax reform having an impact on his company's leasing arrangements, which he claims are relatively small, nor does he expect tax reform to influence the leasing decision of his customers. Economic considerations are more important, he says. "[Many customers] just don't have the cash flow to get into heavy capital equipment investment," he comments. Leasing is a method to ease cash-flow problems rather than one of looking for a lower cost of capital. In this capacity, tax considerations take a backseat to economic necessity.

As for how people will get paid, the use of 401(k)s and incentive stock options (ISOs) are still expected to be popular, but cash will play an increasingly important role in compensation

As a result of tax reform, how will the following factors at your company be changed in 1987?

	Increase	Decrease	No change	Don't know
Profitability	34.2%	26.0%	38.4%	0.0%
Taxes	27.4%	45.2%	26.0%	0.0%
Capital spending	0.0%	27.4%	69.9%	1.4%
Leasing equipment	12.3%	5.5%	78.1%	1.4%
International business	2.7%	4.1%	82.2%	9.6%
Domestic business	4.1%	20.5%	64.4%	9.6%

How will the following factors be affected in 1987 by the Tax Reform Act of 1986?

	Increase	Decrease	No effect	Don't know
GNP growth	24.7%	23.3%	27.4%	23.3%
Interest rates	12.3%	38.4%	24.7%	23.3%
Capital spending	11.0%	76.7%	6.8%	4.1%
Federal budget deficit	45.2%	9.6%	31.5%	12.3%

Indicate what influence the following changes in the tax code will have on your company:

	Very positive effect	Positive effect	Neutral effect	Negative effect	Very negative effect
Capital gains tax increase	0.0%	0.0%	71.2%	17.8%	9.6%
Depreciation schedule changes	0.0%	5.5%	38.4%	50.7%	1.4%
ITC repeal	0.0%	0.0%	12.3%	60.3%	26.0%
R&E credit extension	15.1%	57.5%	21.9%	4.1%	0%
Corporate tax rate decrease	24.7%	53.4%	17.8%	1.4%	1.4%
AMT requirement	0%	0%	60.3%	28.8%	6.8%
Employee compensation changes	0%	4.1%	46.6%	45.2%	1.4%
International tax changes	0%	2.7%	76.7%	13.7%	1.4%

In 1986, did your company consider restructuring under a Subchapter S election, a Master Limited Partnership of any other corporate form as a response to the change in the tax code?

Yes	15.1%
No	83.5%

Will tax reform affect your company's intention to consider mergers or acquisitions now that the Net Operating Loss (NOL) restrictions — not allowing carryovers of NOLs following a 50% change in ownership — have been put in place?

Yes	23%	Not considering any mergers or acquisitions	41%
No	36%		

Do you expect to continue to use subcontractors as a result of the change in Section 1706 of the tax code?

Yes	47%	Don't know	28%
No	25%		

Source: ELECTRONIC BUSINESS

packages. Seventy-seven percent of those surveyed said that they use some type of noncash compensation for employees but only 69% said that they will continue to use it. Seventy-four percent said that they expect cash to become a more desirable compensation alternative.

Many companies say they will play a neutral role in deciding how employees will be compensated now that the tax advantages of capital payments have been removed by the rise in the capital gains tax rate. Start-up companies in need of attracting high-caliber executives will be the hardest hit in this area.

Rodger Barkus, vice president at Analogy Inc., a Beaverton, Oregon-based computer-aided engineering software company, believes incentive stock options are not as attractive as they were prior to tax reform. But, even though cash will become more desirable, Analogy will focus on "sweetening the pot" with equity to attract good people, says Barkus.

The survey also indicates there is a possibility that merger and acquisition activity will be curtailed because the net operating losses of acquired companies can no longer be applied to tax bills. Twenty-three percent of respondents indicated that the net operating loss (NOL) restrictions — limitations on the use of NOL carryovers that can be used against the acquiring company's tax bill — will affect their acquisition decisions, while 36% said it will not.

Whitehead of Vectran believes that the limitations on using NOLs will effectively eliminate any acquisitions made strictly for the reason of tax breaks. In the past, acquisitions were made for two reasons, he says: to acquire technology or to save taxes. The new law now reduces the value of a prospective buy-out because the tax savings have evaporated. This is particularly relevant for start-up companies that have been desirable as tax-shelter takeovers in the past. As an alternative, joint ventures are expected to become more appealing.

The NOL changes are particularly relevant for the fragmented power supply business, says Zytec's Rogers. "In our position of being relatively young, [the NOL restriction] is going to be a big negative." Small power supply manufacturers struggling with losses now become less attractive.

On the international side of business, only 6% of the respondents expect any change in overseas activity as a result of tax reform, while 80% say there will be no change. Many argue it is still too soon to judge what the international consequences of the new tax act will be because there are other issues at play. These include the fall in the value of the dollar and the ongoing trade negotiations between the United States and Japan.

Accountants insist that the international consequences of tax reform are not yet understood. There are many subtle changes — and some not so subtle changes — that will influence where income is declared and even where production will take place. In the long run, issues such as the super royalty tax (giving the IRS the right to revalue the license fee a company charges its foreign buyer whenever it sees fit) and relative changes in international tax rates will play increasingly important roles in business decisions. □

The 1706 battle for independents

There has been a lot of noise from independent software contractors accusing Congress of cutting off their business. By passing the controversial 1706 amendment to the 1986 Tax Reform Act, many contractors (including engineers, designers, drafters, computer programmers, systems analysts or other similarly skilled workers) are claiming they are being forced out of business and must now become employees of the companies that use their services.

From the tax reform survey conducted by ELECTRONIC BUSINESS magazine, 41% of those surveyed said that they use subcontractors for software engineering. When asked if section 1706 would affect their use of subcontractors, 47% said yes, 25% said no, and 28% said they were unsure.

One recently formed organization, the Technical Consultants National Association (TECNA), which represents independent high-technology consultants, was so outraged by Congress' actions, it filed a civil lawsuit against James Baker, secretary of the U.S. Department of Treasury and Lawrence B. Gibbs, the commissioner of the Internal Revenue Service. TECNA claims that section 1706 will "drive thousands of small- to medium-sized high-technology firms out of business and have a disastrous effect on the technological growth in the United States." By press time, neither Baker nor Gibbs had responded to TECNA's lawsuit, according to TECNA's New England lawyer, Francis M. Lynch.

Section 1706 is intended to introduce fairness into the tax code and to weed out those subcontractors that are abusing their status — independent contractors that work side by side with employees for long periods of time, but because of their status, receive more compensation for their work. As the argument goes, if they cannot pass a 20-question IRS qualifying test, their status should be changed to either an employee of the company that they are working for or an employee of a third-party professional services company.

Because of the confusion that section 1706 created, the IRS gave a grace period until March 31, 1987 for companies to clean up their subcontractor relationships. Now, if a company is audited and found wanting, it is responsible for paying back-taxes on its subcontractors and could be subjected to a fine.

Recommendations for confused chief financial officers from ADAPSO, the computer software and services industry association, is straightforward. If you have doubts about subcontracting, ADAPSO says:

- Ask to see the subcontractor's SS8 form — the IRS's statement that the consultant/contractor/subcontractor passed the 20-question qualifying test. Be sure it is a recent ruling
- If the relationship is expected to be a long-term one, contact the IRS and see if the contractor can be legitimately considered a contractor
- If the consultant works for a third-party broker or services company, ask to see that company's W2 form that states the person you are hiring is an employee of that third-party company.

CMOS acceptance spawns complementary markets

As CMOS technology has moved into more and more segments, chips using the process have become a $5.5 billion business

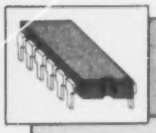
by Valerie Rice

Since its inception in the RCA Corp. laboratories in the 1960s, the CMOS fabrication process has overpowered competitive processes by offering low power consumption and high circuit density. The twin advantages of CMOS have driven complementary metal-oxide semiconductors into every major market sector for a total $5.5 billion in business. New flavors of CMOS are now challenging the segments once thought untouchable.

Semiconductor product managers and buyers agree that CMOS is the favored process for all but the very high-end products. CMOS nay-sayers have vanished, and even bipolar strongholds Texas Instruments and Signetics Corp. have gone CMOS.

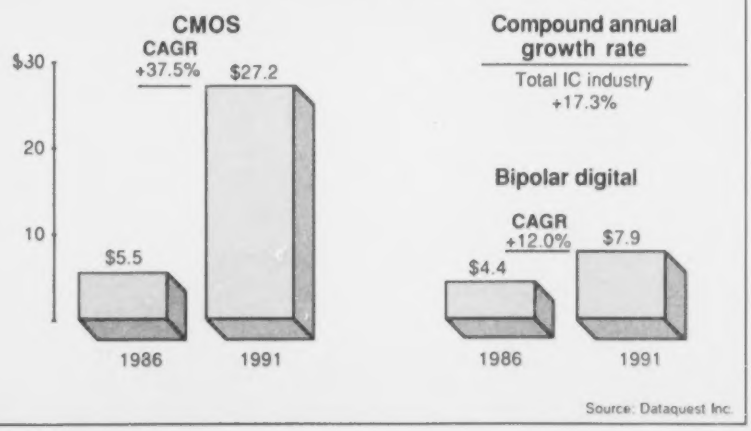
The controversies generated about CMOS have withered. Arguments that the process was too slow, that it encountered continual problems and that the chips were unavailable have been refuted. Technological advances overcame most of the objections and CMOS now offers competitive circuit speed for most applications. CMOS also has consistently low-power requirements, high circuit density and a declining price. To sum up, "CMOS is for the masses — it's like rice," says one industry observer.

As further proof of the power of CMOS, some say it is so ingrained as a standard that it has stopped being a technology. "It is no longer an issue of CMOS versus NMOS [n-channel MOS], or even bipolar," Sunnyvale, California-based Signetics Corp. vice president for marketing Thomas Humphrey says. "It is less a matter of demand for the CMOS technology than for newer products," he says. "The market wants newer products and CMOS is the best way to achieve those newer products. It's hardly a matter of choosing a technology anymore. Rather it's choosing functionality, performance and price."



Growth of CMOS and bipolar digital IC shipments

Worldwide shipments ($ billions)



Source: Dataquest Inc.

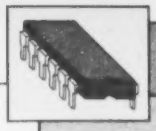
The market size

The numbers behind the phenomenal growth of CMOS support this contention. According to market research firm Dataquest Inc., San Jose, Calif., the CMOS market grew from $1.1 billion in 1981 to $5.5 billion at the end of 1986. It is predicted to grow to $27.2 billion by 1991 with a compound annual growth rate of 37.5% from 1986, a figure that is more than double the growth rate of the industry as a whole. For comparison, bipolar digital is expected to grow at a compound annual growth rate of only 12% during the same time period.

Market research firm In-Stat Inc.'s vice president for technology Bill Groves is more succint: "CMOS gets all the attention and research and development. As far as bipolar is concerned, you can't squeeze blood from a stone."

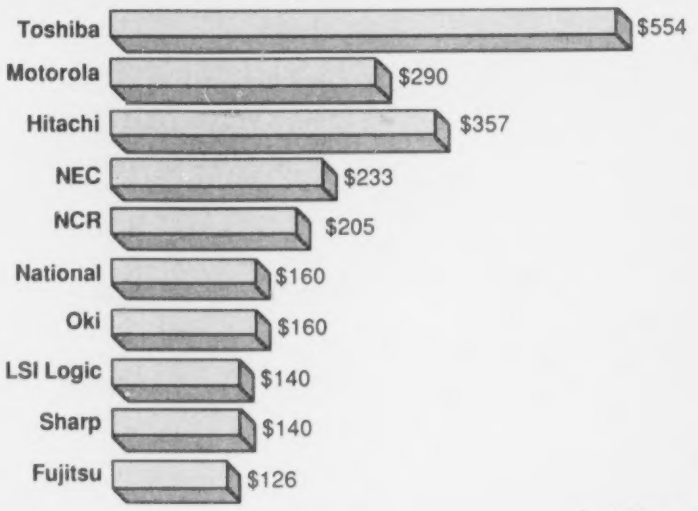
In terms of market share, Dataquest estimates that MOS products (43% are CMOS) outpaced bipolar digital products in 1986 in the data-processing, communications, consumer electronics and transportation segments of the market. This should come as no surprise since many of these applications — particularly communications, automotive and consumer electronics — require low power consumption and have limited battery capabilities.

The reasons supporting this explosive market growth are numerous. Technically, CMOS offers low power requirements, allowing higher circuit densities and more transistors on a single chip than possible with the bi-



CMOS sales leaders in 1985

Estimated worldwide CMOS IC sales ($ millions)



Source: Dataquest Inc.

polar process. Applications that require low power consumption (such as portable computers or satellites) are built on CMOS foundations. CMOS, with its ability to support a very high density of circuits, has also allowed applications to grow increasingly complex. As an example, Fujitsu America Inc. of San Jose has plans to release a 32-bit chip with between 650,000 and 750,000 transistors, and at the end of this year the next version will hold 850,000 transistors. A bipolar chip with that many transistors would "cook in its own juices," Fujitsu executives claim.

Speed, which was once considered a negative in CMOS technology, has now caught up to industry standards and at some levels it approaches that of bipolar. Price, another issue that has slowed the spread of CMOS in the past, is not a problem now, as the price performance ratios between bipolar and CMOS are almost equal. CMOS is still more expensive but offers a much higher and more complex degree of functionality than bipolar. CMOS is also noise immune, making it very suitable for the telecommunications and automobile environments where electrical disturbances and spurious signals can be common.

For all of these reasons, CMOS is the process of choice in the development of new products for virtually every semiconductor manufacturer today. In fact, as research and development progresses, CMOS is entering a number of markets heretofore unheard of, including programmable array logic (PAL), linear, erasable programmable read-only memory (EPROMs) and microprocessors, as well as old standbys such as controllers and application-specific integrated circuits (ASICs).

It is so widespread that many companies are manufacturing all of their new products in only CMOS, including NCR Corp. of Dayton, Ohio, and the microprocessor division of Intel in Santa Clara, Calif. A majority of other companies are finding that CMOS has opened new market niches for them and their customers, and they are planning to capitalize on that in the future with new and advanced product introductions in CMOS.

The statistics

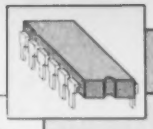
The breadth of CMOS penetration is considerable:

- Twenty-five percent of Intel's automotive division is CMOS. In 18 months or less, executives are predicting 75% will be CMOS
- Delco Electronics Corp., Kokomo, Ind., a captive supplier for General Motors Corp., and a merchant in its own right, currently manufactures 15% to 20% of its products in CMOS, but will have 45% to 50% in CMOS by 1995
- National Semiconductor in Santa Clara produces not more than 50% of its product line in CMOS, but anticipates that about 80% of its products will be in CMOS by the early 1990s
- Although Signetics has only 5% of its products in CMOS today, it plans to double that percentage every year until the end of the decade
- Ford Motor Co., Dearborn, Mich., buys all of its new custom MOS products in CMOS, and most of its microprocessor products are — or will be — in CMOS
- Wyle Distributors, Irvine, Calif., does 90% of its semicustom IC division's business in CMOS.

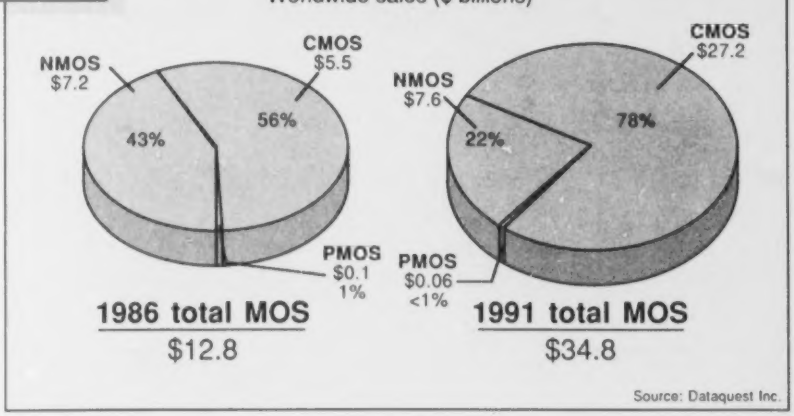
> CMOS is the process of choice in the development of new products for virtually every semiconductor manufacturer today

The deepening market penetration of CMOS goes beyond just new markets and products however, as semiconductor vendors are realizing that CMOS, when applied to "old" technologies, can bring the dead back to life.

Intel's Santa Clara Microcomputer Division marketing manager George Alexy explains that as products reach the last stages of their life cycles, they become more appealing in CMOS as they begin to attract lower end markets. At Intel, the 8088 and 8086 microprocessors were moved to CMOS from their original NMOS, and this is directly on track with their move from the office to the factory floor. For Alexy, this is purely a question of timing. "Where you have more mature products with a lower cost, they can be applied to a whole new wave of applications. These low-end markets are more cost sensitive, so [moving] the 80286 and 80186 [to CMOS from NMOS] would be overkill in terms of performance. Also, because these [low-end] markets are cost sensitive



Total MOS market by process type



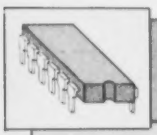
Source: Dataquest Inc.

they look for CMOS because of the lower power and the cooling. By the time the 186/286 are in this cost curve, they too will be moved to CMOS."

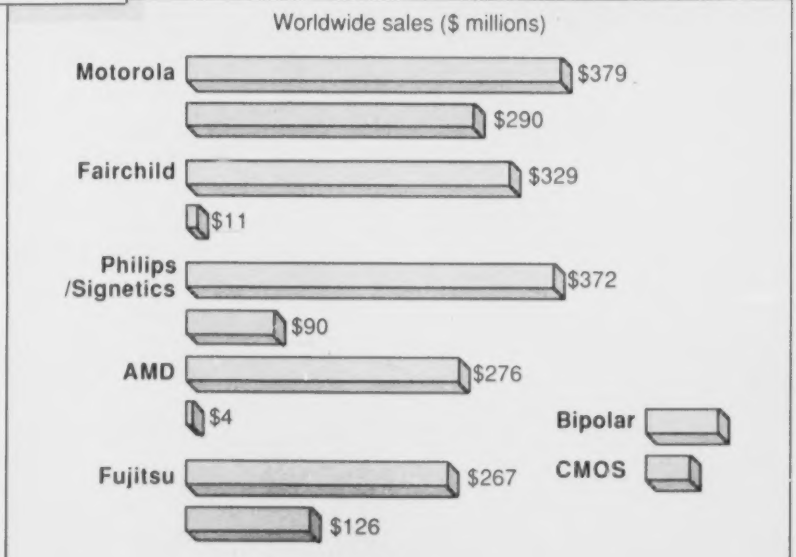
Another area that CMOS has had a great effect on is ASICs, where National's vice president of the ASIC Division, Fred Horn, says "CMOS makes ASICs possible." The extremely high density combined with the low power offers the designer the flexibility to pick the power and the speed, as well as pack the chip full of transistors, Horn says. This makes CMOS the logical ASIC process and has helped push Fujitsu, LSI Logic and National into the top 10 CMOS producers at the end of 1985, according to Dataquest. In-Stat estimates that the MOS content in ASICs/gate arrays will grow from $900 million dollars at the end of 1986 to $2 billion in 1990, and the majority of those dollars will be in CMOS.

Fujitsu has been in the CMOS ASICs business since the mid-1970s. According to CMOS products marketing manager Cliff Vaughan, CMOS was the first process Fujitsu used, then the company followed the market into HCMOS, a high performance version of NMOS designed by Intel. Now Fujitsu is back into pure CMOS ASICs products, and the reasons are clear. Says Vaughan, "CMOS is tolerant. It offers fairly high logic densities, and you can pack more gates per chip than anything else." Also, manufacturing is streamlined within Fujitsu because so many of the different product groups have a heavy reliance on CMOS as well, Vaughan says.

CMOS is making inroads in the combination of digital and analog. Analog, which up until recently has been the province of linear circuits, is now finding new market applications in CMOS, a move that is expanding the market, according to analysts at Integrated Circuit Engineering, a Scottsdale, Arizona-based market research firm. ICE studies show that the low power consumption offered to digital functions from CMOS is also available to analog, which will become increasingly more important to vendors over time. ICE, banking on the continuing trend toward "CMOS only" systems, is forecasting a 37% average annual growth rate over the next five years for CMOS analog ICs.



Top five digital bipolar market leaders and their CMOS sales



Source: Dataquest Inc.

CMOS and bipolar

CMOS and bipolar are also moving closer together. Texas Instrument's Richard Moore, new product engineering manager, says it well. "There is a merge of technologies going on between CMOS and bipolar. We have a BiCMOS logic product line, and it is obvious that each technology brings something to the market. They can complement each other and coexist."

But, if some companies have their way, CMOS will be crowded out in the future by BiCMOS. Offering the so-called best of both worlds, BiCMOS lets designers have the low power and high density aspects of CMOS and the high speed of bipolar. But the controversy rages among vendors as to the actual potential of this product.

Edward Browder, president of Saratoga Semiconductor, a San Jose-based maker of BiCMOS-only emitter-coupled logic (ECL) and transistor-transistor logic (TTL) parts, believes that the increasing demand for speed among system designers will quickly spread the popularity of BiCMOS products across a wide number of markets. "BiCMOS is on the leading edge of speed," he says, "and the demand will be for faster parts, not necessarily because the parts are BiCMOS." But Beaverton, Oregon-based Lattice Semiconductor Corp. president C. Norman Winningstad disagrees. "BiCMOS is a restricted market, a niche market," he says. "You don't always have a need for fantastic speed and output. I don't think the

extra cost will justify the product enough to spread it over a broad spectrum of markets."

Although CMOS is practically the de facto standard process for many products, other processes have continued to grow. Bipolar, for example, historically offered a designer high speed, particularly in the driver area, although it required large amounts of power and cooling. "When you want an application to be really fast today, you have to have speed, you have to choose bipolar," Lattice's Winningstad says. Bipolar is still the process of choice for the very fast, high-end TTL and ECL environments.

Dramatic speed and density increases in recent years have also given CMOS a price performance ratio very similar to that of bipolar. Bipolar is still cheaper, Dataquest's senior industry analyst Andrew Prophet says, but it is less bang for the buck. Other MOS technologies operating in the same arena as CMOS are NMOS and p-channel MOS (PMOS). By all accounts, PMOS is a dead technology, or will be by the early 1990s. According to Dataquest, PMOS has only a $1 million share of the overall MOS market today and will have a $600,000 share in 1991. NMOS, on the other hand, is at least holding its own in the short term.

Companies like Intel have made heavy investments in NMOS, and have been relatively slow in moving over to CMOS technology. In fact, Intel's automotive group does 75% of its business in HMOS (NMOS). The reason, automotive strategic marketing manager Fred Phail hastens to explain, is that Intel's largest customer, Ford Motor Co., has ordered more than one million engine control units from Intel in HMOS. Phail says that over the next 18 months the products will be converted to CMOS and, at that point, more than 75% of his business should be CMOS. □

Get the long cord

When you send a satellite into space, the extension cord just gets longer and longer. This is why, says a TRW spokesperson, the company liked CMOS. Because the military's satellites are so far out they require low power consumption, high density and low cooling requirements. "CMOS has opened new markets for us," Hughes Microelectronics Center's semiconductor products marketing manager Carroll Perkins says. "In digital signal processing in particular, where there are requirements for complex logic, CMOS has opened up quite a few new markets."

According to Integrated Circuit Engineering (ICE), a Scottsdale, Arizona-based market research firm, 25% of the military market at the end of 1986 was CMOS, and by 1988 use of CMOS logic will increase by 15%, and memory will increase by over 20%.

Intel Corp.'s marketing manager for military applications, Robert Singer, targets four main military markets that are well-suited to CMOS. They are communications, command, control and guidance which take CMOS capabilities out to the battlefield where the requirements are for low standby power; electronic warfare systems — including jammers and electromagnetic systems for aircraft — which have to be both low power and highly reliable, as well as radiation tolerant; airborne radar, which have to be low power; and missiles, which have limited space so the density has to be high and the power consumption has to be low.

Despite the Electronic Industry Association's predictions of flat growth for the military market until the end of the decade, a number of vendors find selling CMOS products to the military a stable business. Hughes Microelectronics Center does 90% of its business for the military (including 10% that is captively sold to Hughes Aircraft), and 95% of the shipments are CMOS. Intel currently produces about 35% of its military products in CMOS, and it has been up over 20% in the last few years; Singer predicts that by the end of the decade, 75% of Intel's products will use CMOS. There are several reasons for this, he says. "The biggest drive right now is the introduction of newer, more complicated, powerful products, like the 80386, which has 350,000 transistors on it. We can't do that in HMOS because there is too much power output."

International Device Technology, a San Jose, California-based semiconductor manufacturer, views the military market as one of the most regular buyers of its CMOS-only products. "The military market has had a stabilizing influence on our growth," marketing vice president William Snow says. IDT sells CMOS static RAMs into the military market and has found the military moving from NMOS to CMOS at about the same rate as the commercial market.

RCA Corp. estimates that it has a 50% to 60% share of the CMOS military market, which is fitting since it considers CMOS its "birthright." RCA developed CMOS in its Princeton, N.J., laboratories in the 1960s and has been manufacturing in CMOS ever since.

Another trend Intel's Singer notes is that as military suppliers integrate CMOS processors into their systems, they want the memory and peripheral products moved to CMOS as well. This helps insure a continuing business for CMOS products in the military, Singer says.

One of the biggest problems military developers must face, however, is making CMOS radiation hard. "The only semiconductor technology that is technically softer than CMOS is NMOS," ROLM Mil-Spec Computer's manager of hardware product marketing William Morrison says. "Bipolar is naturally much harder."

The problems with radiation hardness occur in two ways and at three different levels, according to ROLM executives. In space, there is a degree of natural radiation or ionization that takes place, and companies that build satellites, such as TRW, have to protect against space radiation. ROLM, which builds earth-based systems, must plan for a grimmer future: nuclear war.

"In a tactical nuclear environment, electromagnetic pulses occur, and they have a different effect than space ionization," Morrison said. "Although levels of radiation hardness are coming up in CMOS, you still have to protect against three different levels of radiation, including neutrons, and two levels of gamma rays."

IDT is currently involved in a research and development effort to "build a technology that is truly rad hard," Snow says. □

Venture capital: Knowing when the price is right

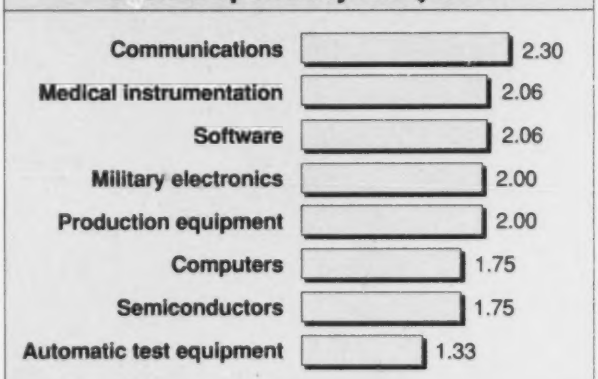
Venture capitalists say there's still plenty of money available for start-up electronics firms in uncrowded niches

By Bruce C.P. Rayner

Since the downturn in 1985, just being a high-tech firm is no longer enough to ensure backing from a venture capitalist. The stakes have been raised and the investors are more discerning. To be convincing today, a company needs a niche market and a competent managerial team to exploit it. For entrepreneurs that can satisfy these criteria, the money is there.

A recent poll of 45 venture capital firms by ELECTRONIC BUSINESS magazine — which we believe is 95% accurate, plus or minus 3% — confirms these findings. Of those polled, 78% described the outlook for the computer and electronics industry in the second half of 1987 as "good" or "excellent." Only 22% said the outlook was "average." And none characterized the outlook as "poor." Of the industry sectors that are experiencing the highest start-up activity this year, communication equipment was singled out most frequently. Medical instrumentation and software start-ups also fared well. (The poll is based on a questionnaire mailed to 465 venture capitalists earlier this year; the response rate was 10%.)

What sectors of the industry do you expect will experience the highest rate of start-up activity this year?



Respondents were asked to rank sectors in order of importance (3 = most important; 2 = moderately important; 1 = least important)

Source: ELECTRONIC BUSINESS

But what the poll does not reflect is what's good for venture capital is not always good for management. In terms of pricing, for example, most venture capitalists think the costs of investments are currently good. The valuation of many publicly traded electronics companies, venture capitalists say, has stayed down chiefly because the industry had a bad year in 1986. But with a generally bullish stock market, those values are creeping up, and with them, the value of privately held, venture-backed companies.

But despite the low valuations of electronics stock, the number of initial public offerings (IPOs) more than doubled in 1986 to 97, up from 46 in 1985, reports Venture Economics Inc., a market research firm in Wellesley, Mass. Although there is some concern that these IPOs may have been undervalued, it is one way venture capitalists cash in.

Acquisitions were also up in 1986 to an estimated 120, almost reaching the 1983 record of 121. Part of the reason for the mushrooming could be attributed to the pending tax reform and part to the undervaluation of the investments in a depressed market.

Charles J. Coulter, president of American Research & Development Inc. (ARD), the Boston-based venture capital firm, believes that pricing now is "realistic." In the early part of the decade, he says, the valuation of some of these high-tech companies was way out of hand. "I don't think they are low and I don't think they are too high. I think they are probably just right," he comments.

Anthony M. Lamport, a managing director at Drexel, Burnham Lambert Inc. in New York, a firm that manages a $40 million venture capital fund, believes that IPOs will be strong in 1987. He says there is "a big rush" of companies filing to go public because they see the market improving. "It takes awhile before they become public," he comments, "but you will see a lot of them in the next few months."

Gourd rattling

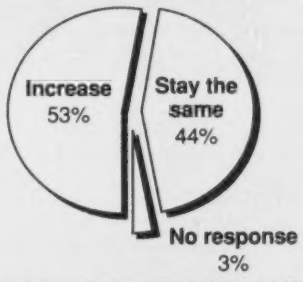
Whether valuation will pick up this year will depend largely on the performance of the electronics industry. As one venture capitalist quips: "We are praying and hoping, shaking beads and rattling gourds to make the situation turn around in 1987." But more than voodoo is needed to return the venture capital market to top health. What many are relying on is a more discriminating assessment of potential ventures. As Stanley E. Pratt, chairman of Venture Economics, says: "Venture capitalists are paying a great deal more attention toward the basics of the business." ▷

Those basics, Pratt says, are driven by market opportunities and not the technology of the product. "Where venture capitalists really want to invest is in a small niche that clearly meets a market need." Where they went wrong in the past, he adds, is they chased technology for the sake of technology. They need to do their homework better and cull out those that will be successful, preferably in uncrowded niche markets, he advises.

Everyone in the business has their own strategy for picking the winners: Coulter of ARD looks for long-term investments in an emerging or core technology and a proprietary method; Sigmund E. Herzstein, an investment manager at Arthur D. Little Ventures, a limited partnership in Cambridge, Mass., that has Arthur D. Little Inc. as an investor, says he looks for very strong individuals with good credentials and a track record in their industry combined with a product with a "fairly high technical contribution."

What venture capitalists shy away from is a focus on a segment of the industry. Instead, most attempt to evaluate potential investments on a case-by-case basis. Mainstream semiconductor and computer companies are viewed with disdain, notes James Fitzpatrick, a senior vice president with General Electric Venture Capital Corp. in Westport, Conn. Fitzpatrick singles out the communications field — specifically in Ku-band satellites and fiber optics for local area networks — as one of the bright spots in an otherwise lackluster field.

In 1987, will your investment in electronics companies:



Significantly, none of the respondents said electronics investments would decrease. And 69% said overall investments, which include nonelectronics companies, would increase in 1987

"Broadly speaking, communications is still a hot area," Pratt concurs. But he warns that it is not the technology that is the central attraction; it is how that technology is used to fulfill market needs. "We have a saying in venture capital," he says: "You can match a first-rate management team with a second-rate product and have success, but you can almost never have success when you back a second-rate management team with a first-rate product."

Tax impact

Meanwhile, the changing tax climate is also having an impact on the ability of start-up electronics companies to attract venture capital. Many venture capitalists are worried about the negative impact the Tax Reform Act of 1986 will have on business. Because the capital gains tax rate has been raised from 20% to 28%, riskier investments in early stage start-up companies are less likely to find backing. Junk bonds, in fact, are a safer haven. The higher capital gains rate also means it will be harder to attract top-grade managers to emerging companies, particularly in the later stage of refinancing.

Another aspect of tax reform — the new limitations placed on the use of net operating loss (NOL) carryforwards — now makes the acquisition of companies with bottom-line losses worth less to prospective buyers. Indeed, any significant change in ownership, including refinancing, means that NOLs will become almost useless.

Under the new regulations, losses of companies that change hands can no longer be used to the same extent as before to offset the taxes of acquiring companies. The result could be a significant decline in the value of the company being acquired. This has

1986 top 20 venture capital firms in electronics

Rank	Company name	Location	Total investments in electronics companies ($ millions)	Total portfolio ($ millions)	Total investments ($ millions)
1	**Hambrecht & Quist Venture Partners**	San Francisco, Calif.	$69.8	$600.0	$93.0
2	**Sprout Group**	New York, N.Y.	31.0	120.0	47.0
3	**General Instrument**	New York, N.Y.	30.0	550.0	30.0
4	**Kleiner Perkins Caufield Byers**	San Francisco, Calif.	29.9	386.6	34.1
5	**Oak Investment Partners**	Westport, Conn.	29.0	37.0	34.0
6	**Institutional Venture Partners**	Menlo Park, Calif.	26.0	152.5	29.0
7	**J.H. Whitney & Co.**	New York, N.Y.	23.3	NA	25.4
8	**Brentwood Associates**	Los Angeles, Calif.	23.0	269.0	40.4
9	**Robertson Colman Stephens**	San Francisco, Calif.	22.8	93.0	38.0
10	**First Chicago Venture Capital**	Chicago, Ill.	22.2	61.5	135.0
11	**U.S. Venture Partners**	Menlo Park, Calif.	20.5	171.0	42.1
12	**Merrill Pickard Anderson Eyre**	Palo Alto, Calif.	16.0	180.0	16.0
13	**Mayfield Fund**	Menlo Park, Calif.	13.8	200.0	19.3
14	**GE Venture Capital**	Fairfield, Conn.	13.0	21.0	18.6
15	**Interwest Partners**	Menlo Park, Calif.	13.0	153.0	17.0
16	**Menlo Ventures**	Menlo Park, Calif.	12.5	150.0	15.0
17	**Warburg Pincus Ventures**	New York, N.Y.	12.0	1,600.0	93.8
18	**Montgomery Securities**	San Francisco, Calif.	11.4	96.4	14.0
19	**Dougery Jones and Wilder**	Mountain View, Calif.	11.2	86.0	15.1
20	**Summit Ventures**	Boston, Mass.	11.0	160.0	23.0

NA = Not available

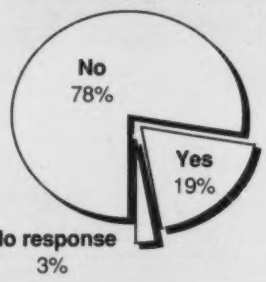
ramifications for companies that are going through the refinancing process, as this is also considered a change in ownership.

All aspects of venture capital are affected, including both investors and entrepreneurs, adds Daniel T. Kingsley, executive director of the Arlington, Virginia-based National Venture Capital Association (NVAC), a trade association for venture capitalists. In the post tax-reform environment, says Kingsley, the question of risk becomes a bigger factor. Although there is no hard data, the NVAC director believes that less risky later-stage financing will become more popular among venture capitalists in the future.

International currency fluctuations and the strategic outlook of large investors toward high-tech firms are also having an impact on the venture capital scene. The weakened dollar, venture capitalists say, is a mixed blessing for the industry, making foreign capital harder to raise, but also opening up foreign markets to U.S. companies. From 1985 to 1986 the share of foreign sources of venture capital dropped from 23% to 11%, reports Venture Economics. This was caused in part by the declining dollar but also because of the increasing importance of pension funds which grew from 33% in 1985 to 49% last year.

Meanwhile, partnership arrangements are expected to play a larger role among start-up firms in the years ahead. These arrangements have been growing in importance for reasons other than tax advantages, but with the new NOL restrictions, they become even more appealing. In a strategic partnership, a large corporation can funnel money into an emerging company without having to take control. The small company benefits by retaining its independence but can tap the financial and marketing strength of its bigger partner. At the same time, the larger company benefits from the proprietary technology the small company offers.

Does your company invest in overseas start-ups?



A third of those polled maintain strategic alliances with overseas venture capital firms.

As an example, Herzstein of ADL Ventures points to a strategic partnership deal his firm has formed with Aeonic Systems Inc. of Billerica, Mass. Aeonic is a 3-year-old company that produces a computer-integrated manufacturing (CIM) control system — software and remote process-control units — for monitoring the production of plastics and paper. In January of this year, Hercules Inc., an aerospace chemical and plastics company based in Wilmington, Del., sank an undisclosed amount into the business, Herzstein says, with the intention of developing Aeonic Systems control system for the paper-processing business. Hercules maintains a minority interest but has the option of increasing its share. The relationship is working well so far, says Herzstein.

James Bourque, vice president for marketing and sales at Aeonic Systems agrees that Hercules made a smart move. By leaving Aeonic intact as a separate entity the incentives for employees are retained and creativity is not stifled. It would have been a mistake to imprint Hercules' corporate style on the budding company, says Bourque. He adds, however, that Aeonic benefits from the resources that Hercules provides.

The ELECTRONIC BUSINESS *venture capital survey, tabulations and directory were compiled by assistant editor Nancy McSharry.*

Electronics investments as a percentage of total investments	Average investment per deal	Average electronics investment per deal	Total number of deals	Total number of deals in electronics companies	Number of deals in electronics companies as a percentage of total deals	Planned investments in 1987 ($ millions)	Preferred stage of investment
75.0%	NA	NA	NA	NA	NA	$69.0	No preference
66.0%	$1,192,308	$5,222,222	26	9	35%	30.0	No preference
100.0%	2,307,692	2,307,692	13	13	100%	NA	No preference
87.7%	1,033,333	1,150,000	33	26	79%	29.0	Seed, first
85.3%	693,878	644,444	49	45	92%	29.0	Seed, first
89.7%	828,571	8,666,667	35	3	9%	28.0	Seed, first
NA	846,667	1,060,000	30	22	73%	30.0	No preference
56.9%	1,010,000	958,333	40	24	60%	37.5	Seed, first, second
60.0%	1,000,000	1,036,364	38	22	58%	27.0	Seed, first
16.4%	1,901,408	854,501	71	26	37%	130.0	Mezzanine, follow-on
48.7%	957,872	855,324	44	24	55%	65.0	No preference
100.0%	761,905	761,905	21	21	100%	15.0	Start-up, seed, first
71.5%	584,848	511,111	33	27	82%	25.0	Start-up, seed, first
69.9%	620,000	619,048	30	21	70%	NA	No preference
76.5%	739,130	866,667	23	15	65%	17.0	Seed, first
83.3%	1,250,000	1,250,000	12	10	83%	2.0	Seed, first, second
12.8%	3,474,074	1,090,909	27	11	41%	NA	Seed, first
81.4%	466,667	518,182	30	22	73%	NA	Seed, mezzanine
74.1%	686,364	746,667	22	15	68%	13.0	Seed, first
47.8%	1,769,231	1,571,429	13	7	54%	25.0	No preference

Source: ELECTRONIC BUSINESS

Who's who in venture capital

Directory of venture capital contacts

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Accel Partners
One Palmer Square, Princeton, N.J. 08542
Dickson R. Doll, Arthur C. Patterson, James R. Swartz: (609) 683-4500

$110	$8.6	$7.1	14	12

Adler & Company
375 Park Avenue, Suite 3303, New York, N.Y. 10152
Frederick R. Adler, Yuval Binur, Joy London, Daniel O'Neill, David Blumberg, Gary Grimm, John Hamann, Gill Cogan: (212) 759-2800

Advanced Technology Ventures
10 Post Office Square, Suite 1230, Boston, Mass. 02109
Albert E. Paladino: (617) 423-4050

$73	$42	$10	16	16

Alan Patricof Associates Inc.
545 Madison Avenue, New York, N.Y. 10022
Kathryn Neal, Rebecca Ryan, Lewis Solomon: (212) 753-6300

$250	$35.8	$4.9	67	19

Al Stern Associates Inc.
1127 So. Patrick Drive, Suite 3, Satellite Beach, Fla. 32937
Al Stern: (305) 777-2018

Arthur D. Little Ventures L.P.
20 Acorn Park, Cambridge, Mass. 02140
Walter Cairns: (617) 864-5770

$15	$1.8	$1.8	8	8

Asset Management Co.
2275 E. Bayshore Road, Palo Alto, Calif. 94303
John Shock, Craig Taylor: (415) 494-7400

$90	$11	$8	20	15

BancBoston Ventures
100 Federal Street, Boston, Mass. 02110
Paul Hogan: (617) 434-2442

$35	$6.5	$2.5	8	3

Bay Partners
10600 North DeAnza Boulevard, Cupertino, Calif. 95014
G. Hazel: (408) 725-2444

$95	$8	$7.8	10	9

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Battery Ventures
200 Portland Street, Boston, Mass. 02114
Howard Anderson, Robert G. Barrett, Richard D. Frisbie, general partners: (617) 367-1011

Beta Ventures Inc.
One Post Office Square, Suite 3800, Boston, Mass. 02109
Frank Kenny: (617) 482-8020

$15	NA	NA	NA	NA

Blalack-Loop Inc.
696 East Colorado Boulevard, Suite 220, Pasadena, Calif. 91101
Charles M. Blalack: (818) 449-3411

NA	$10	$10	3	3

Brentwood Associates
11661 San Vicente Boulevard, Suite 707, Los Angeles, Calif. 90049
G. Bradford Jones, general partner; Leslie R. Shaw, vice president, finance: (213) 826-6581

$269	$40.4	$23	40	24

Bridge Capital Investors
50 Broadway, 29th floor, New York, N.Y. 10004
Alex Jeffers: (212) 514-6700

$100	$22	$3.5	6	2

Burr, Egan, Deleage & Co.
One Post Office Square, Suite 3800, Boston, Mass. 02109
Esther Sharp: (617) 482-8020

$10.8	$15.8	$4.8	41	8

CFB Venture Capital
530 B Street, San Diego, Calif. 92112
Richard Roncaglia: (619) 230-3304

Charles River Ventures
67 Batterymarch Street, Boston, Mass. 02110
(617) 482-9370

$150	$17	$10	8	4

Charter Venture Capital
525 University Avenue, Suite 1500, Palo Alto, Calif. 94301
A. Barr Dolan: (415) 325-6953

NA	NA	NA	14	7

(continued)

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Churchill International
444 Market Street, San Francisco, Calif. 94111
Roy Helsing: (415) 398-7677

$40	$2.2	$2.2	4	4

Comp-U-Net
4350 Palm Avenue, La Mesa, Calif. 92041
Paul Franc: (619) 698-1517

Coleman Ventures Inc.
5909 Northern Boulevard, East Norwich, N.Y. 11732
Gregory S. Coleman: (516) 626-3642

$1	$0.5	$0.5	2	2

Coronado Venture Fund
800 North Swan, Suite 130, Tucson, Ariz. 85711
James M. Strickland, managing partner: (602) 326-6778

$1.2	$0.4	$0.3	3	2

Corporate Finance Associates Inc. of Georgia
6600 Peachtree Dunwoody Road, Building 300, Suite 670, Atlanta, Ga. 30328
David O. Ellis: (404) 399-5633

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Crosspoint Venture Partners
1951 Landings Drive, Mountain View, Calif. 94043
John B. Mumford: (415) 964-0100

$65	$12	$10.5	10	8

Dajen Corp.
9 Lundy Lane, Larchmont, N.Y. 10538
Robert Cohen: (201) 837-9118; (914) 834-8510

Dougery, Jones & Wilder
2003 Landings Drive, Mountain View, Calif. 94043
John R. Dougery, David A. Jones, Gerald R. Schoonhoven, Henry L.B. Wilder: (415) 968-4820
Two Lincoln Centre, Suite 1100, 5400 LBJ Freeway, Dallas, Texas 75240
A. Lawson Howard: (214) 960-0077

$86	$15.1	$11.2	22	15

Eastech Management Company Inc.
One Liberty Square, 9th floor, Boston, Mass. 02109
Michael H. Shanahan: (617) 338-0200

$34.3	$2.2	$2.2	22	22

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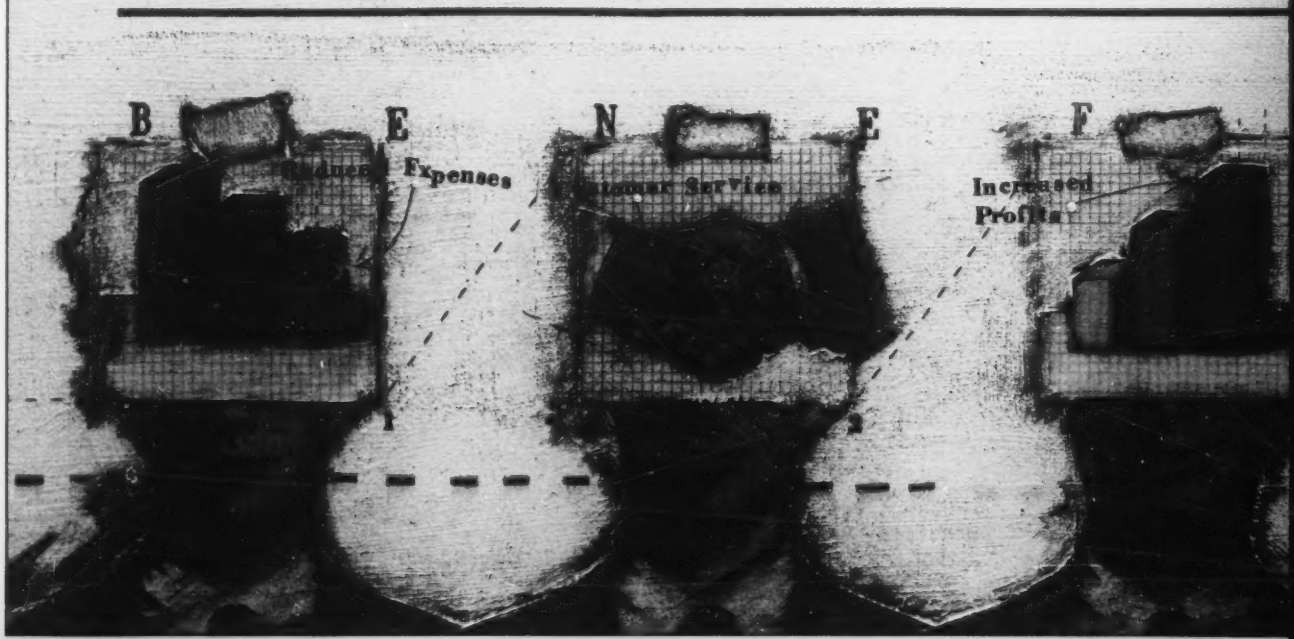

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Fairfield Venture Partners
1275 Summer Street, Stamford, Conn. 06905
Oakes Ames: (203) 358-0255; (714) 754-5717

$100	$12	$8.5	24	14

FBS Venture Capital
6900 E. Camelback Road, #452, Scottsdale, Ariz. 58251
William B. McKee: (602) 941-2160

First Analysis Management Company
20 North Wacker Drive, Chicago, Ill. 60636
Bret R. Maxwell: (312) 372-3111

First Boston Venture Capital
Park Avenue Plaza, 40th floor, New York, N.Y. 10055
Harold Bogle, Jeffrey Parker: (212) 909-4582

NA	$25.9	$3.5	18	10

First Century Partners
1345 Avenue of the Americas, New York, N.Y. 10105
David S. Lobel, Lisa Roumell, Geoffrey Y. Yang: (212) 698-6383

$150	$15	$10	9	6

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

First Chicago Venture Capital
3 First National Plaza, Suite 1330, Chicago, Ill. 60670
Kent P. Dauten: (312) 732-5400; Kevin M. McCaffrey: (617) 542-9185

$61.5	$135	$22	71	26

Frontenac Venture Co.
208 South LaSalle Street, Suite 1900, Chicago, Ill. 60604
Martin Koldyke: (312) 368-0044

$182	$18	$1.7	18	5

General Electric Venture Capital
3135 Easton Turnpike, Fairfield, Conn. 06431
(203) 373-3333

$21	$18.6	$13	30	21

General Instrument
767 Fifth Avenue, New York, N.Y. 10153
Edward Keraney: (212) 207-6200

$550	$30	$30	13	13

Grace Ventures Corp.
20300 Stevens Creek Boulevard, Suite 330, Cupertino, Calif. 95014 Christian Horn: (408) 725-0774

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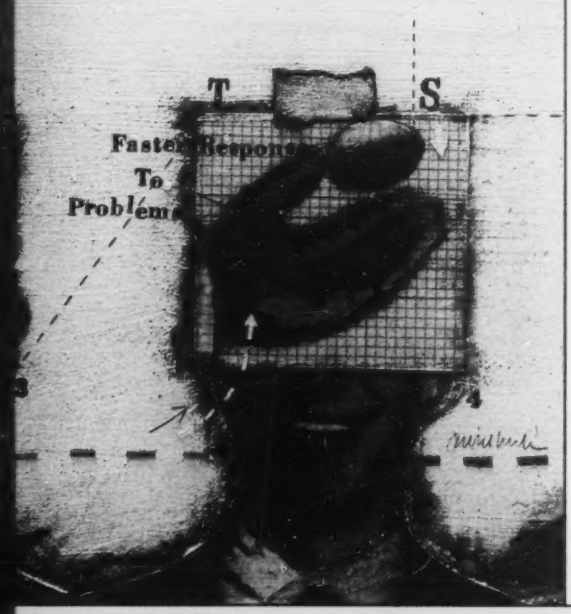

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communications company ℠

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Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Greylock Management
1 Federal Street, Boston, Mass. 02110
Dan Gregory, William Helman: (617) 423-5525

NA	$19.4	$11	26	11

Hambrecht & Quist Venture Partners
235 Montgomery Street, San Francisco, Calif. 94104
Ken Guernsey, Bob Kunze: (415) 986-5500

$600	$93	$69.75	NA	NA

Hambro International Venture Fund
17 East 71st Street, New York, N.Y. 94104
Bob Bertolli, Julie Lane: (212) 288-7778

$80	$15	$7.5	12	6

Happ Ventures
444 Castro Street, Suite 400, Mountain View, Calif. 94041
William D. Happ: (415) 961-1115

Hill, Kirby & Washing
885 Arapahoe, Boulder, Colo. 80302
John G. Hill, Paul J. Kirby, Thomas G. Washing: (303) 442-5151

$6	$5.8	$0.9	8	3

Inco Venture Capital Management
One New York Plaza, New York, N.Y. 10004
Stuart F. Feiner: (212) 612-5620

$70	$10	$3.3	20	11

IndoSuez Technology Group
3000 Sand Hill Road, Building 4, Suite 130, Menlo Park, Calif. 94025
David E. Gold, Phillipe Sevin: (415) 854-0587

$34	$4	$2.8	8	5

Institutional Venture Partners
3000 Sand Hill Road, Building 2, Suite 290, Menlo Park, Calif. 94025
John Poitras: (415) 854-0132

$96	$29	$29	35	35

Intersouth Partners
P.O. Box 13546, Research Triangle Park, N.C. 27709
Dennis J. Dougherty: (919) 544-6473

Interwest Partners
3000 Sand Hill Road, Building 3, Suite 255, Menlo Park, Calif. 95025
Chuck McMinn: (415) 854-8585

$153	$17	$13	23	15

JAFCO America Ventures Inc.
2180 Sand Hill Road, Suite 270, Menlo Park, Calif. 94025
S. Fukada: (415) 854-0746

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

J.H. Whitney & Co.
630 Fifth Avenue, New York, N.Y. 10111
Edward V. Ryan: (212) 422-3933

$200	$25.4	$23.2	30	22

Kleiner Perkins Caufield Byers
4 Embarcadero Suite 3520, San Francisco, Calif. 94111
Mike Curry: (415) 421-3110

$386.6	$34.1	$29.9	33	26

The Lambda Funds
55 Broad Street, New York, N.Y. 10004
Alexa Mahnken: (212) 480-5160

$40	$6.1	$4	18	11

Lawrence Venture Associates
515 Madison Avenue, 29th floor, New York, N.Y. 10022
Brian T. Horey: (212) 826-9080

$68	$9	$2.4	10	3

Leverage Inc.
8615 Wild Olive Drive, Potomac, Md. 20854
L. Wasserman: (301) 230-0701

Matrix Partners
One Post Office Square, Suite 3840, Boston, Mass. 02109
W. Michael Humphreys: (617) 482-7735

$115	$16.6	$9.2	25	15

Mayfield Fund
2200 Sand Hill Road, Suite 200, Menlo Park, Calif. 94025
Norman A. Fogelsong: (415) 854-5560

$200	$19.3	$13.8	33	27

MBW Management Inc.
365 South Street, Morristown, N.J. 07960
Philip E. McCarthy, managing director: (201) 285-5533

Melchor Venture Management
170 State Street, Suite 220, Los Altos, Calif. 94022
Gregory Young: (415) 941-6565

Menlo Ventures
3000 Sand Hill Road, Bldg. 4, Suite 100, Menlo Park, Calif. 94025
DuBose Montgomery: (415) 854-8540

$150	$15	$12.5	12	10

Merrill Pickard Anderson Eyre
2 Palo Alto Square, Suite 425, Palo Alto, Calif. 94306
Jeff Pickard: (415) 856-8880

$180	$16	$16	21	21

Mesirow Venture Capital
350 N. Clark Street, Chicago, Ill. 60610
James C. Tyree, managing director: (312) 670-6000

$75	$5.75	$1.65	6	1

(continued)

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Mitec Ventures
2727 N. Bristol Street, Suite 108, Santa Ana, Calif. 92706
M.L. "Bud" Warrick: (714) 953-2731

Montgomery Securities
600 Montgomery Street, San Francisco, Calif. 94111
James Pelkey: (415) 627-2000

$96.4	$14	$11.4	30	22

Morgenthaler Venture
700 National City Bank Building, Cleveland, Ohio 44114
Robert C. Bellas Jr.: (216) 621-3070

$100	$13.9	$5.1	20	9

Morgan Holland Ventures Corp.
One Liberty Square, Boston, Mass. 02109
(617) 423-1765

$58.6	$6.5	$6	6	5

Morgan Stanley Ventures
101 California Street, San Francisco, Calif. 94111
Robert L. Burr, general partner: (415) 576-2345

$39.2	$4.5	$4.5	2	2

MSA Ventures
3101 Thistlewood, Thousand Oaks, Calif. 91360
Martin S. Albert: (805) 492-2275

Narragansett Capital Inc.
40 Westminster Street, Providence, R.I. 02903
A.D. Little: (401) 751-1000

NA	NA	0	7	0

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

NEPA Venture Fund L.P.
125 Goodman Drive, Bethlehem, Pa. 18015
Frederick J. Bestelli, Glen R. Bressner: (215) 865-6550

$11	$0.68	$0.6	2	1

New Venture Development Corp.
1025 Thomas Jefferson, #400 E, Washington, D.C. 20007
David A. Shaw: (202) 944-3636

Oak Investment Partners
257 Riverside Avenue, Westport, Conn. 06880
Ron Verilli: (203) 226-8346

$37	$34	$29	49	45

Olympic Venture Partners
411 108th Street N.E. Suite 1710, Bellevue, Wash. 98004
George Clute: (206) 455-1470

$68.4	$5	$5	7	7

Orange Nassau
260 Franklin Street, Suite 1500, Boston, Mass. 02110
(617) 451-6220

$110	$21	$8.1	11	4

Palmer Partners
300 Unicorn Park, Woburn, Mass. 01801
William H. Congleton, general partner: (617) 933-5445

$50	$7.6	$5	24	17

The Pittsford Group
8 Lodge Pole Road, Pittsford, N.Y. 14534-3814
Logan M. Cheek III: (716) 223-3523

$40	$3.5	$1	3	1

(continued)

MENLO VENTURES

3000 Sand Hill Road, Bldg. 4, Suite 100
Menlo Park, CA 94025, 415-854-8540

CONTACTS:
DuBose Montgomery, Ken Joy, Doug Carlisle, Rick Magnuson, Tom Bredt, Denise O'Leary, John Jarve, and Michael Riordan

TYPE OF FIRM:
Private venture capital firm with over $150 million under management.

AFFILIATIONS:
Affiliations with leading institutional investors from corporations, pension funds, insurance companies, banks, and universities.

PREFERRED PROJECTS:
Start-ups, later-stage financings, leverage buyouts.

GEOGRAPHIC PREFERENCE: United States

INDUSTRY SEGMENT PREFERENCE:
Computers, communications, software, medical and other electronic-related industries.

OTHER INFORMATION:
Menlo Ventures has been in business for more than a decade and has successfully financed more than 80 emerging companies in a wide range of industries.

RAYTHEON VENTURES

141 Spring Street
Lexington, MA 02173, 617-860-2270

CONTACTS:
David R.A. Steadman, President
Clyde E. Rettig, Vice President

TYPE OF FIRM:
Corporate venture capital arm investing own funds

AFFILIATIONS:
Raytheon Company

PREFERRED PROJECTS:
Early stage and later high technology/strategic investments

GEOGRAPHIC PREFERENCE:
No preference

INDUSTRY SEGMENT PREFERENCE:
Electronics, computers, communications, semiconductors and other related businesses

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Raytheon Ventures
141 Spring Street, Lexington, Mass. 02173
David R.A. Steadman: (617) 860-2270

Regional Financial Enterprises
36 Grove Street, New Canaan, Conn. 06840
George Thomassy: (203) 966-2800

$142	$50	$10	54	19

Robertson Colman Stephens
One Embarcadero Center, Suite 3100,San Francisco, Calif. 94111
R. Lee Douglas, Gary W. Masner, J. Matthew Mackowski, Paul H. Stephens: (415) 781-9700

$93	$38	$22.8	38	22

Rothschild Ventures
3000 Sand Hill Road, Building 3, Suite 260, Menlo Park, Calif. 94025
J. Michael Gullard: (415) 854-2576

$7.3	$2.6	$1	5	3

Security Pacific Capital Corp.
650 Town Center Drive, Costa Mesa, Calif. 92626
Tim Hay: (714) 556-1964

Sierra Ventures
3000 Sand Hill Road, Building 1, Suite 280, Menlo Park, Calif. 94205
Peter Wendell, Vincent Topkin: (415) 854-1000

$75	$9	$5.5	8	5

Sigma Partners
2099 Gateway, Suite 310, San Jose, Calif. 95110
J. Burgess Jamieson: (408) 279-6300

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Southern California Ventures
9920 La Cienega Boulevard, Suite 510, Inglewood, Calif. 90301
Jay Raskin, B. Allen Lay: (213) 216-0544

$18.95	$2.4	$1.2	3	2

Southwest Venture Partnerships
300 Convent, Suite 1400, San Antonio, Texas 78205
John Long: (512) 227-1010

$75	$9.7	$1.7	6	1

Sprout Group
140 Broadway, New York, N.Y. 10005
Richard E. Kroon: (212) 504-3600

$120	$31	$47	26	9

Summit Ventures
One Boston Place, Boston, Mass. 02108
Eric Shealy: (617) 742-5500

$160	$23	$11	13	7

Sutter Hill Ventures
2 Palo Alto Square, Suite 700, Palo Alto, Calif. 94306
Paul M. Wythes: (415) 493-5600

$200	$10	$10	8	8

TA Associates
45 Milk Street, Boston, Mass. 02109
Robert W. Daly, C. Kevin Landry, P. Andrews McLane, Jacqueline C. Morby: (617) 574-6715
435 Tasso Street, Suite 200, Palo Alto, Calif. 94301
Jack Bunce, Jeffrey T. Chambers, Michael C. Child: (415) 328-1210

$570	$54	$1.8	37	1

American Electronics Association AEA and Electronic Business present:

日本

Japan Electronics:
A Business and Technology Update

The Japan Electronics seminar on October 7 in Osaka is designed to help European and U.S. executives seek out new business opportunities in Japan. The day-long seminar, which will coincide with the Japan Electronics Show, has been structured to provide attendees with a statistical overview of the Japanese electronics industry, as well as a preview of upcoming technological trends.

The seminar is intended both as an introduction to Japan for first-time visitors as well as an update of Japanese business and technology for seasoned travelers in the Far East.

DATE:
October 7, 1987
In conjunction with the Japan Electronics Show

LOCATION:
Royal Hotel, Osaka, Japan

SEMINAR FEE:
$350

OFFICIAL LANGUAGE:
English

CO-SPONSORS:
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U.S. Electronics Industry Japan Office
Japan Electronics Show Assoc.
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EDN magazine
Elektronica of Holland
Plesman Publications of Canada

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Thomas Group
2001 Gateway Place, Suite 200W, San Jose, Calif. 94022
Thomas J. Popek: (408) 280-5115

NA	NA	NA	4	2

Trinity Ventures Ltd.
20813 Stevens Creek Boulevard, Suite 101, Cupertino, Calif. 95014
Jerry Casilli, Noel Fenton, David Nierenberg: (408) 446-9690

$8.3	$7.6	$4.5	9	7

U.S. Venture Partners
2180 Sand Hill Road, Suite 300, Menlo Park, Calif. 94025
Bruce J. Boehm, William K. Bowes Jr., Nancy Glaser, Steven Krausz, Roderick C.M. Hall, H. Joseph Horowitz, Jane H. Martin, Stuart G. Moldaw, Robert Sackman, Philip S. Schlein: (415) 854-9080

$171	$42.1	$20.5	44	24

Vast Company Inc.
500 Archdale Drive, Charlotte, N.C. 28210
Peter F. Lai: (704) 527-1537

Vencon Management
301 West 53rd Street, New York, N.Y. 10019
Irvin Barash: (212) 581-8787

Ventana
19600 Fairchild, Suite 150, Irvine, Calif. 92715
Stan Fleming, Thomas O. Gephart: (714) 476-2204

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies

Venture Funding Group Ltd.
49 West 12th Street, Executive Suite, New York, N.Y. 10011
Allan E. Skora: (212) 691-9895

NA	$10.5	$4.8	14	5

The Vista Group
36 Grove Street, New Canaan, Conn. 06840
Mary Lou Mitzovich: (203) 972-3400

$225	$13	$7.5	22	7

Wachtel & Company Inc.
1101 14th Street N.W., Washington, D.C. 20005
John D. Sanders: (202) 898-1144

$2	$2	$1.2	11	4

Warburg Pincus Ventures
466 Lexington Avenue, New York, N.Y. 10017
Nissan Boury: (212) 878-0671

$1,600	$93.8	$12	27	11

Yamaichi Uni-Ven
333 South Hope Street, Los Angeles, Calif. 90071
Ken Kawabe: (213) 626-0401

Xerox Venture Capital
800 Long Ridge Road, Stamford, Conn. 06904
L.J. Harris: (203) 968-3383

NA	$6.5	NA	7	NA

Zero Stage Capital Company Inc.
One Broadway, 10th floor, Cambridge, Mass. 02142
Gordon B. Baty, David Dominik, Neil R. Henry, Paul M. Kelley: (617) 876-5355

$35	$1.8	$1	6	4

SPEAKERS:

Kaoro Kubo, v.p. and general manager of NTT International
Kazuhiko Kobayashi, manager of the Systems Engineering Division of Hitachi
Hiroshi Komiya, head, Saijou Works, Mitsubishi Electric
Bill Totten, pres. of Ashisuto KK
David H. Johnson, senior manager for Network Systems Sales, AT&T International Japan
Dinker Bir, v.p. technology at Northern Telecom Japan
Pat O'Malley, strategic marketing director for the Semiconductor Sector at Nippon Motorola
Gen Narui, regional manager for Educational Services at Nihon Digital Equipment
Stephen Donovan, representative director of Monolithic Memories
Shohei Kurita, Tokyo editor for Electronic Business, author.
Gene Norrett, v.p. and director of the Semiconductor Industry Group, Dataquest
Alberto Socolovsky, associate publisher and editorial director of Electronic Business.
Yoshiro Yoshioka, deputy general manager, Mainframe Division, Information Processing Group, Fujitsu
Nobuyoshi Yokobori, manager of the R&D Planning Office, Corporate Engineering Division, Matsushita Electric Industrial
Masaru Yamano, executive vice president, Sanyo Electrics
Tadashi Sasaki, corporate management advisor, Sharp
Nobuo Tateishi, executive v.p., Omron Tateishi Electronics

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1076 AZ Amsterdam
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Corporate AI R&D accelerates in Japan

There are now an estimated 1,000 artificial intelligence products under development in Japan, mostly at large firms

Artificial intelligence research is continuing at a feverish pace in Japan, despite the country's economic slowdown. Today there are an estimated 1,000 AI products under development in Japan for in-house use at about 100 companies.

And there are no signs that AI fever, which first struck the country in 1984, shows any signs of abating. All of the major corporations in Japan are either importing "shells," the software framework around which expert systems are written, or buying domestically made shells.

By 1990, the Japanese market for AI software — including commercial software as well as software developed for in-house systems — is expected to reach ¥960 billion, or $6.4 billion ($1=¥150); and by 1995, the market will soar to ¥4,785 billion, or $31.9 billion — using the same currency conversion rate. This represents an annual average growth rate of 37.8%. The market for AI hardware, on the other hand — including all forms of computer architecture, both traditional and nontraditional — will grow to ¥247.2 billion, or $1.648 billion by 1990; by 1995, the hardware market will reach ¥894.6 billion, or $5.964 billion. The estimates, which presuppose that Japan's gross national product (GNP) will grow 3.5% annually, were made by the AI Subcommittee of the AI Vision Committee of the Institute of New Generation Computer Technology (ICOT). ICOT is an organization, supported by the Ministry of International Trade and Industry (MITI), to promote the development of Fifth-Generation computers. And the subcommittee, which drew up these forecasts, consists of representatives of leading computer manufacturers, large-scale computer users, and a number of scholars.

Nevertheless, for the moment, AI commercial activity is still very limited. To date, in Japan, there are only about 10 software shells on the market. That compares with about 100 shells currently available in the United States for use in customizing expert systems for specific end-user applications.

> The really big AI activity now occuring in Japan is taking place in the research labs of large electronics companies

The relatively smaller number of Japanese-made shells may be a factor in why Japan still lags the United States in commercially available expert systems. While the American AI community is attempting to produce numerous expert systems — for use in medical diagnosis, oil field exploration and military weapons systems — there is only one commercialized expert system currently on the market in Japan. The vendor is Nihon Shakai Iryou Kenkyusho (English translation: Japan Medical Laboratory); and the product is "Zhang Zhong Qing," an expert system which recommends herbs and other traditional Chinese medicines based on a description of the patient's symptoms fed into the system by a medical technician. Since its introduction last November, Nihon has sold 15 of the software packages, which run on an NEC Corp. business microcomputer. In addition, Kaou, a soap company, has shipped several experimental expert systems to Japanese department stores to advise salespersons on which cosmetic products to recommend, depending on the characteristics of the customer's skin.

Lab work

If one includes the sales of shells, machine translation systems, higher language software products used in AI research, or proprietary expert systems developed by large firms in conjunction with users, then the Japanese AI market is much larger. Nihon Univac Kaisha, for example, has sold about 10 shell copies of KEE software from Intellicorp of Menlo Park, Calif. The shells run on NUK's KS301 Lisp machine. And Digital Equipment Corp. Japan has delivered about 100 OPS.5 shells; 150 systems offering VAX Lisp, a very popular AI language; not to mention reselling assorted AI software products from Teknowledge Inc. and AI Technologies Corp.

The really big AI activity now occurring in Japan, however, is taking place in the research labs at large multinational electronics companies. "We have 75 AI projects [going on] in the Computer Division alone," one Fujitsu Ltd. insider, who asked not to be identified, recently told ELECTRONIC BUSINESS. And a manager in the Computer Division at Hitachi Ltd. claims his company now has 120 AI projects on the books.

Bit by bit, though, many of these products are beginning to see the light of day. The following is a synopsis of AI and AI-related products now available from some of Japan's largest computer houses:

- **Fujitsu.** The company has delivered 130 mainframe shells, 30 microcomputer shells and an undisclosed number of ESHELL-SB superminicomputer shells used in real-time processing for manufacturing applications. Introduced last October, the ESHELL-SB can be used to develop expert systems using raw data directly acquired from instruments and other measuring devices on the factory floor. It has also sold 50 units of Facom Alpha which it claims is the

AI in Japan: Vital statistics

Number of firms investing in AI	100 (estimate)
Number of expert systems	1,000
Number of commercial shells	10
Number of commercial expert systems	1
Number of Japanese firms selling AI machines developed in house	3*

* Fujitsu, Mitsubishi and NTT

Source: ELECTRONIC BUSINESS

JAPAN REPORT

world's fastest Lisp machine; and 190 of its Atlas Model I and Model II machine translation systems.

- **Hitachi.** In addition to its Motorola 68020-based Creative Workstation 2050, which it claims has potential AI-related office automation applications, Hitachi also offers a Hitac E-7300 workstation for the AI engineering environment. Altogether, it has sold about 100 model ES-Kernal shells for the 2050 workstation. Hitachi also says it has sold 30 machine translation systems to universities, banks, laboratories and other large institutions.
- **IBM Japan.** The company now offers four AI languages for its mainframes. In cooperation with Carnegie Mellon University, it is also developing a two-way Japanese-English translation system due in 1989.
- **Mitsubishi Electric Corp.** Based partly on a prototype of the Personal Sequential Inference machine developed for ICOT and Japan's Fifth Generation Computer Project, Mitsubishi has delivered 30 shells which run on its own $133,000 Prolog-language machine. The company is also developing a machine translation system.
- **NEC.** The company has delivered 20 shells for its ACOS mainframe series and five multilingual machine translation systems which can translate documents from English to Japanese and Japanese to English. It has also delivered a knowledge-based fingerprint recognition system to about 20 police departments around the world.
- **Toshiba Corp.** Along with an AI shell for its Unix supermini series, Toshiba also offers a microcomputer-based shell. In addition, the company has shipped 10 machine translation systems.

Other Japanese companies with AI products on the market include Mitsubishi Research Institute; Toyou Information System (which offers packages which run on Symbolics Corp. AI processors); Nippon Telephone & Telegraph (which sells NTT-developed AI software products through DEC Japan and has just announced its own Lisp workstation); and Bravice International, the pioneer in the machine translation system market. Bravice has sold 2,200 Japanese-to-English software packages which run on NEC and IBM desktop machines. And the independent software house also offers systems for English-to-French translation, English-to-German and English-to-Spanish.

SHOHEI KURITA

CALENDAR

UNITED STATES

May 18. **Opportunities in Flat-Panel Displays**. Ritz-Carlton Hotel, Boston. Arthur D. Little Inc. (617) 864-5770

May 18-21. **SEMICON/West**. San Mateo Fairgrounds, San Mateo, Calif. Semiconductor Equipment and Materials Institute (SEMI). (415) 964-5111

May 27-29. **AEA Financial Conference for Emerging Growth Companies**. Hyatt Regency Hotel, Monterey, Calif. American Electronics Association (AEA). (415) 857-9300

May 30 - June 2. **Summer Consumer Electronics Show**. McCormick Place, Chicago. Electronic Industries Association/Consumer Electronic Group (EIA). (202) 457-8700

June 1-4. **COMDEX Spring**. Georgia World Congress Center, Atlanta. The Interface Group. (617) 449-6600

CEG June 9-11. **NEPCON East '87**. Bayside Exposition Center and World Trade Center, Boston. Cahners Exposition Group. (312) 299-9311

June 9-11. **VISION '87**. Applied machine vision conference & exposition. Cobo Hall, Detroit. Machine Vision Association of SME (MVA/SME), Automated Vision Association (AVA). (313) 271-1500

June 15-18. **NCC '87**. National Computer Conference. McCormick Place, Chicago. American Federation of Information Processing Societies, Association for Computing Machinery, Data Processing Management Association, Institute for Electrical and Electronics Engineers (IEEE) Computer Society and Society for Computer Simulation. (703) 620-8970

CEG June 16-18. **ISC Expo 87**. International Security Conference and Exposition. O'Hare Exposition Center, Rosemont, Ill. Cahners Exposition Group. (312) 299-9311

June 22-25. **ATE East**. World Trade Center, Boston. Morgan-Grampian Expositions Group. (800) 223-7126

June 28-July 1. **Design Automation Conference**. Miami Beach Convention Center, Miami Beach, Fla. IEEE and ACM. (303) 530-4562

July 27-31. **Siggraph '87**. The 14th annual conference on computer graphics and interactive techniques. Anaheim Convention Center, Anaheim, Calif. Siggraph '87 Conference Management. (312) 644-6610

CEG Aug. 24-26. **ISC Expo East 87**. International Security Conference and Exposition. Jacob Javits Convention Center, New York City. Cahners Exposition Group. (312) 299-9311

Sept. 1-3. **International Test Conference 1987**. Sheraton Washington Hotel, Washington, D.C. IEEE Computer Society, IEEE Philadelphia Section. (201) 895-5260

Sept. 9-11. **Seminar on Modern Electronic Packaging**. Marriott Sea-Tac Hotel, Seattle. Technology Seminars. (301) 269-4102

Sept. 15-17. **Midcon**. O'Hare Exposition Center, Chicago. Electronics Conventions Management. (213) 772-2965

Sept. 22-24. **SEMICON/East**. Bayside Exposition Center, Boston. Semiconductor Equipment and Materials Institute (SEMI). (415) 964-5111

Sept. 22-24. **Northcon**. Portland Memorial Coliseum. Portland, Ore. Electronic Conventions Management. (213) 772-2965.

CEG Sept. 26-28. **CEPS VI**. Corporate Electronics Publishing Systems. World Trade Center, Boston. Cahners Exposition Group. (203) 964-8287

CEG Sept. 29-Oct. 2. **INFO/Information Management Exposition and Conference**. Jacob Javits Convention Center, New York City. Cahners Exposition Group. (203) 964-0000

Oct. 5-9. **EIA Fall Conference**. Century Plaza Hotel, Los Angeles. Electronic Industries Association (EIA). (202) 457-4900

Oct. 14-15. **SEMICON/Southwest**. Infomart, Dallas. Semiconductor Equipment and Materials Institute (SEMI). (415) 964-5111

Oct. 19-21. **Connectors and Interconnection Technology Symposium**. Franklin Plaza Hotel, Philadelphia. Electronic Connector Study Group. (215) 825-3840

Oct. 25-30. **AEA Monterey Financial Conference**. Hyatt Regency Hotel, Monterey, Calif. American Electronics Association (AEA). (415) 857-9300 ▷